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CHROMOSOME MORPHOLOGY OF CERTAIN RACES OF MAIZE IN LATIN AMERICA

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CHROMOSOME MORPHOLOGY OF CERTAIN RACES OF MAIZE IN LATIN AMERICA

Albert E. Longley [1] and Takeo A. Kato Y. [2]

INTRODUCTION

The study of the morphological features of the mid-prophase chromosomes of the microspore-mother-cells of maize was initiated thirty-five years ago, when it was found that aceto-carmine stained the chromosomes at this early phase. As time passed, more and more data were published on the chromosome knob complement, the most variable feature of the mid-prophase chromosomes of maize. These data came from material found in the Americas ranging from the Northern United States in North America to Chile in South America.

During the years 1960 to 1962, the authors studied the chromosomes of some of the primitive races of maize in Mexico, Central and South America, and of races and varietal groups of Central America and the Caribbean Islands. These studies were planned to determine the morphological features of the chromosomes of distinct types of maize, hoping to detect characteristics associated with each race and with races from different areas and environments.

These chromosome studies were part of the cooperative program between the Mexican Ministry of Agriculture and the Rockefeller Foundation in maize improvement. Through the cooperative effort of these two Institutions in past years, and more recently with the help of the National Academy of Sciences - National Research Council, all the major maize types of Mexico, Central America and the Caribbean have been brought together and are being preserved by the Foundation at the National School of Agriculture at Chapingo, Mexico, along with the collector's data for each collection.

Wellhausen, et al (21, 23) devised a system of classification which they used in classifying the many types of maize collected throughout Mexico and Central America. This classification is based primarily on plant, ear and seed characters. In their classification, many of the groups were given race status and named. Similarly, Brown (2) classified the maize

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in the West Indies into races. Seed of all these races are stored under controlled conditions of temperature and humidity at Chapingo. Seed is renovated when necessary by controlled random pollination in a way to avoid as much inbreeding as possible in consideration of the number of varieties and races involved.

Plants from seed of selected races being maintained in this way in the Maize Bank at Chapingo, provided microspore-mother-cell material for our chromosome studies. The microspores were stained in aceto-carmine and camera lucida drawings were made of each chromosome of each plant. These drawings show the major markings, such as prominent chromomeres and knobs, along the thread-like bivalent mid-prophase chromosomes.

The chromosomes of more than 1,500 plants have been studied and the drawings are filed and are available for future reference. These drawings provide data on the activity at twenty different knob-forming areas in the chromosomes found in representative samples from a large number of collections.

The paired mid-prophase chromosomes of microspore-mother-cells of maize have characteristics that make it possible to distinguish each of the ten bivalents, when properly stained, and examined under a high-powered microscope (x 1000). Relative length, relative lengths of arms and in some chromosomes, distinctive chromomeres are used to recognize each chromosome, but deeply staining heterochromatic knobs, when present, are very useful identification aids (Figure 2). These knobs are found at knob-forming regions in bivalent chromosomes. Any of those paired regions may be without a knob or paired regions may have one of several knob sizes.

The variation in size of the knob formed at a knob-forming region has been recognized as an important feature of the data recorded in our drawings. The different grades in knob size are known to be constant and each knob size is known to be transmitted unchanged from one generation to the next. Consequently, a particular knob of a certain size may be characteristic of a maize race.

Not only are there variations in size of a particular knob, but there are also variations in the number of active knob-forming regions. Consequently, the number of knobs present in a plant, a race, or the maize growing in a particular region, may be a distinctive characteristic.

Six grades of activity (high-high, high-low, high-0, low-low, low-0 and 0-0) would produce knobs on bivalent chromosomes ranging in size from 0-5. This arbitrary grading of knob size has been used for each of the 20 paired knob-forming regions that may be active in the material. An additional step in activity between high and low would require more than six grades to describe the variation in knob size at each paired knob region of bivalent chromosomes.

The assigning of only 0-5 steps in knob size and since each is thought to be a stable form, one can visualize an almost innumerable number of different knob combinations when 120 different bivalent knobs are free to combine at random. A characteristic knob complex for the chromosomes of a corn race or group would be recognized only if one or a few of the large number of possible knob combinations are found present in representative plants.

The evaluation of the activity of a knob-forming position by the size of the knob produced is not entirely satisfactory due to the personal element that is involved; but a careful grading of the knob size at the time a drawing is made, eliminates many of the grading difficulties. The presence of heterozygous knobs at some positions was recorded in our drawings, but data used in this presentation records only the size of each knob, without an attempt to separate a homozygous from a heterozygous condition.

The presence of heterozygosity at a specific knob-forming position is difficult to detect at mid-prophase microspore-mother-cells. Material from a selfed progeny should show, at a position heterozygous for knob-forming activity in the parent, one fourth of the positions homozygous for one or the other of the two parent knob types. However, such a test of heterozygosity gives no clue to the time when this heterozygosity originated. It may have been recently or it may have been hundreds of generations prior to the time of collection.

The production of extra large knobs at cert in knob-forming regions, such as are found in this maize knob survey, has proven useful in tracing the distribution of maize from a common center of origin.

Dr. McClintock's notes drew our attention to the much larger concentration of knob material adjacent to the nucleolar organizer of 6S. We found this enlarged knob frequently in Mexican and Guatemalan collections and in one collection from Panama and in one from Venezuela. Ocassionally the large knob had a twin appearance which suggested that a crossing over or exchange at this knob-forming region had been diagonal and the knob-forming region was duplicated in one and lost from the other of the paired chromosomes (Figure 1-A). These and other observations lead to the conclusions that extra large knobs are due to the compounding of a knob-forming region. Such a compounding would serve to explain the large, irregular shaped knob usually seen on 4 L (Figure 1-E).

The long arm of chromosome six, so frequently marked by twin knobs had in annual Euchlaena and in several instances, three knobs present. This duplication of one of the two knobs suggested that the usual twin knobs of 6L were due to a duplication that included a short piece of the adjacent euchromatic thread.

That the duplication process could pyramid upon itself was demonstrated in some plants of Guerrero Teosinte. Figure 1-C shows 6L with a normal and a second enlarged knob, while Figure 1-D shows 6L with three knobs. Thus, it seems that a method of building a large block of heterochromatin has been detected. For years the origin of B-type and the piece terminating the long arm of chromosome 10 has been puzzling. The compounding of knob-forming regions provides a method that would build such blocks of heterochromatin at any knob-forming region. A translocation would suffice to transfer such a block to the end of 10L. Our material provided three instances in which this or a similar block of material has been retransferred to 9L, 9S and 2L. Figures 1-G, H, and I.

The formation of a B-type chromosome of a block of heterochromatin on an A-type chromosome would require more than a simple translocation, to give it its present form. The extra steps make a duplicate origin of a B-type chromosome so unlikely that one concludes that all B-type chromosomes have a common origin. Therefore a B-type chromosome ties the plant in which it is found to the original plant in which the first B-type was created. Since B-types are found almost everywhere where maize is grown, one concludes that maize everywhere comes from a common center.

The common center from which a B-type chromosome most likely originated would be a center where the maize chromosomes had knobs, consequently the maize growing at the fringes of zones of adaptation with B-types would be tied to maize at a center where chromosome knobs prevailed.

The distribution of the abnormal form of chromosome 10 is much more limited (Tables 3b and 2c) than B-types and that of the enlarged knob adjacent to the organizer on 6S is even more limited. These large blocks of heterochromatin may have originated in much the same area as B-types, but their distributions suggest a more recent date of origin.

The knob-forming region may, by mutation or by series of mutations, lose its activity, but a compound block of heterochromatin would require many more mutational changes to eliminate it and so such a chromosome as a B-type has persisted, although most chromosome knobs on A-type chromosomes could disappear.

In this publication, the large volume of data on the knobs of each chromosome complement of approximately 1500 plants, has been divided into four sections: (A) Chromosome morphology of primitive races of maize in Mexico, Central and South America; (B) The chromosomes of Central American maize; (C) The chromosomes of Caribbean maize and (D) Discussion and conclusions.

To introduce the reader to pertinent data on the geographical areas, the differences in environment, the races and groups and the prevalence and size of the knobs involved, Table 1 in the appendix has been prepared.

Section A discusses the knob situation in primitive corns from a wide range of locations, and surveys the relationship between knob complexes of different races from different geographical regions and different environments. This treatment should serve to establish the presence or absence of a characteristic knob complex associated with a particular race, area or environment.

Section B discusses the knob situation in corn collections from six Central American countries, which includes many races and groups. This survey is intended to answer questions similar to those raised for primitive corn collections.

Section C discusses the knob situation in corn collections from the Caribbean Islands. This material eliminates, to a large degree, the differences in altitude noted for the Central American countries and substitutes for mountain valley isolation, the isolation characteristic of some islands. This survey will, again, stress the presence or absence of specific chromosome complexes for certain islands and for the various corn races and varietal groups.

Section D, as the title indicates, involves a discussion of the data as a whole and general conclusions drawn from them by the authors.

Figure 1. Origin of large masses of heterochromatic material.
A. Twin knobs adjacent to the nucleolar organizer on 6S. Yucatan 7.
B. Normal chromosome 6. Nicaragua 3432.
C. Much enlarged knob on 6Lc found in teosinte Guerrero 249.
D. Triple knobs at distal positions on 6L found in teosinte Guerrero 249.
E. Twin knobs on 4L from Costa Rica 45.
F. Duplication of the heterochromatic piece of abnormal chromosome 10 from Nicaragua 3432.
G. An heterochromatic block, similar to that terminating abnormal chromosome 10, terminating 9L. Guatemala 835.
H. An heterochromatic block, similar to that terminating abnormal chromosome 10, terminating 9S. Costa Rica 400.
I. An heterochromatic block, similar to that terminating abnormal chromosome 10, terminating 2L. Guatemala 207.

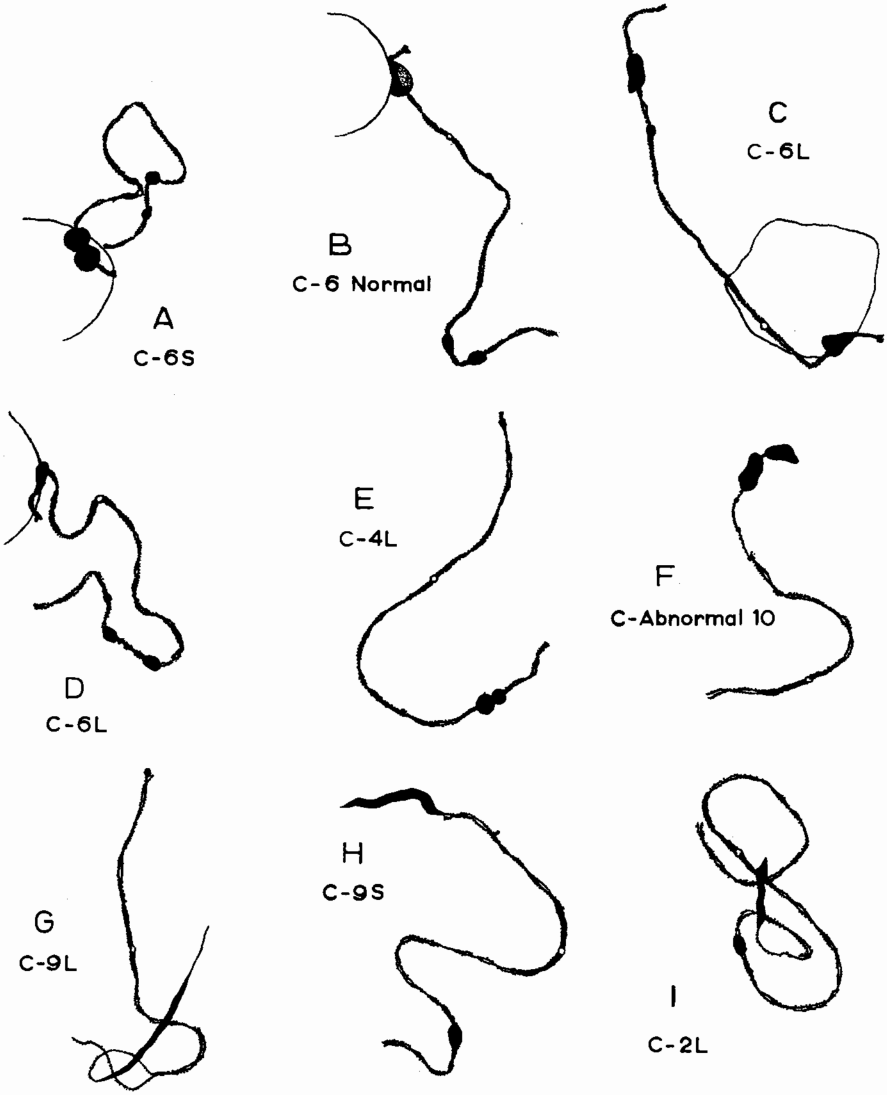
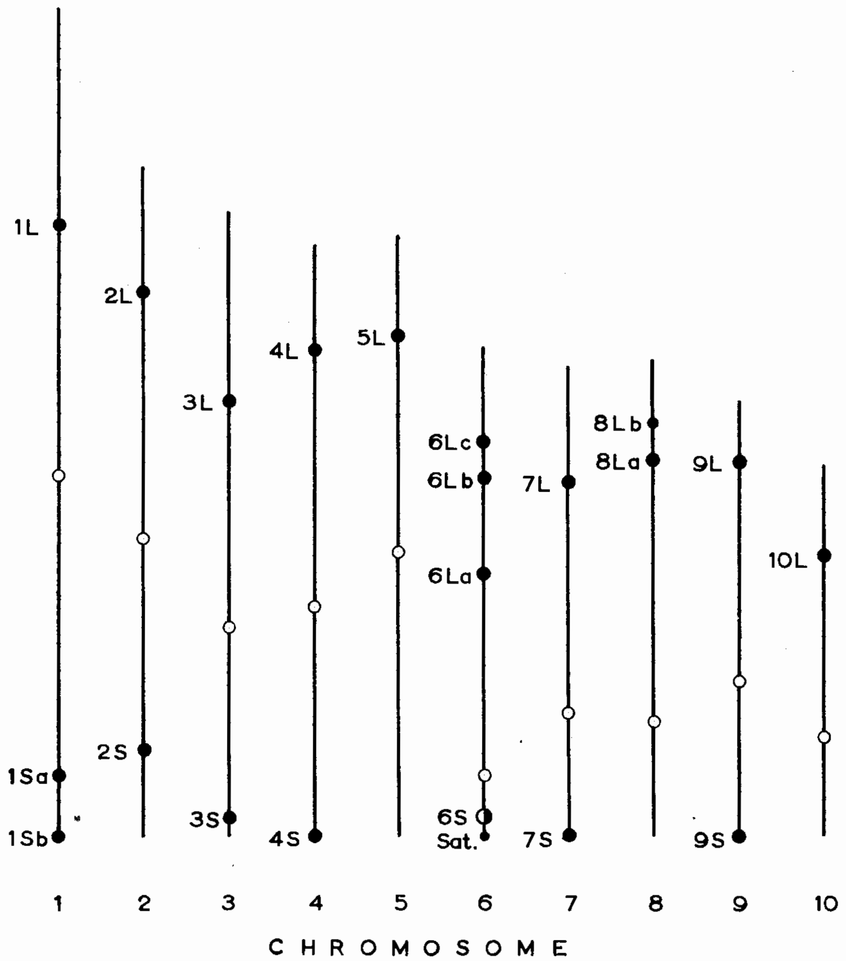


Figure 2. Diagram showing the relative location and the designation used for each one of the 20 chromosome knobs found in all corn collections studied.



S E C T I O N - A

CHROMOSOME MORPHOLOGY OF PRIMITIVE RACES OF MAIZE IN MEXICO, CENTRAL AND SOUTH AMERICA

Takeo A. Kato Y., and Albert E. Longley.

INTRODUCTION

Available data indicate that the early cultivated varieties of maize in Mexico were of the Nal-Tel-Chapalote complex or their prototypes. These two primitive races still found in certain areas of Mexico and Central America were described by Wellhausen, et al (21, 23). Mangelsdorf, MacNeish and Galinat (11) in a study of prehistoric plant remains of maize in the Tehuacán Valley of Puebla, Mexico, concluded that it was this corn which initiated the rapid expansion of agriculture during the period from 900 B.C. to 1536 A.D. in Mexico. According to these authors the plant remains of corn discovered by MacNeish and his associates in the excavations of caves in the Tehuacán Valley includes the oldest well-preserved cobs yet found which date back to 5200 B.C. and are thought to be those of wild maize. The cob collections as a whole portray a well-defined evolutionary sequence from what is thought to be wild corn to the ancient indigenous races of Mexico, Nal-Tel and Chapalote.

It appears that these two ancient races or their prototypes were spread to various parts of Mexico, Central and South America in prehistoric times. The earliest corn discovered in La Perra Cave in Tamaulipas, in Northeastern Mexico by MacNeish in 1949 dated 2500 B.C., was identified by Mangelsdorf, MacNeish and Galinat (11) as an early form of Nal-Tel. The oldest cobs discovered in Swallow Cave in Northwestern Mexico by Robert H. Lister of the University of Colorado, were identified by Mangelsdorf and Lister (12) as prototypes of Chapalote. Wellhausen, et al (23) concluded that the basic types of corn cultivated in the early stages of the Maya civilization in Guatemala were of the Nal-Tel - Chapalote complex. Wellhausen, et al (23) described five more or less distinct types of Nal-Tel still in existence at a wide range of altitudes in Guatemala and have described varieties similar to Nal-Tel existing in Central America from Guatemala to Panama.

In Colombia the primitive race Pollo, described by Roberts, et al (17) was found to have many morphological characters in common with the Nal-Tel - Chapalote complex of Mexico and Central America. Pollo also has morphological resemblances to the primitive race Confite Morocho described by Grobman, et al (4) in Peru. Another relationship mentioned by Roberts, et al

(17) is with the race Sabanero of Colombia with which it supposedly has introgressed reciprocally. Also, the race Pollo has been described in Venezuela by Grant, et al (3) as being similar to Nal-Tel of Guatemala and Sabanero of Colombia in some of its morphological characters.

Grant, et al (3) consider the primitive race Aragüito of Venezuela as being very similar to the white Nal-Tel of Central America. Also the two primitive races, Guaribero and Canilla of Venezuela have been described by Grant, et al (3) as being very similar to Aragüito in many of their morphological characters.

The race Pira was described by Roberts, et al (17) in Colombia and by Grant, et al (3) in Venezuela as one of the primitive races in that region. It has been pointed out by Roberts, et al (17) that this race is probably related to the popcorns of Peru, Confite Morocho and Confite Puntiagudo. Recently Wellhausen (unpublished) found a race in Costa Rica and Panama which he has named Maicena A. The morphological characteristics of this race are almost identical to those of Pira, including the flexible cob.

Although the race Pororo, described by Ramírez et al (15) in Bolivia is not classified as primitive, it is indicated that it is similar to Pira of Colombia.

The race Enano has been described as a primitive race by Grobman, et al (4) in Peru. This race has also been described in Bolivia by Ramírez, et al (15) and by Timothy, et al (20) in Ecuador.

The races Confite Morocho and Confite Puntiagudo have been described by Grobman, et al (4) in Peru. According to Grobman, et al (4), Confite Morocho is one of the most ancient primitive races of maize in South America and is related to Confite Puntiagudo in Peru, Pisinkalla in Bolivia and Pollo in Colombia. Grobman, et al (4) indicate that possibly Palomero Toluqueño of Mexico was derived indirectly from Confite Morocho through one of its derivative races, Confite Puntiagudo or Pisinkalla.

The race Pisinkalla of Bolivia was described by Ramírez et al (15).

The race Canguil was described by Timothy, et al (20) in Ecuador, and it is considered to be similar to Pisinkalla of Bolivia in its morphological characteristics.

The race Sabanero is one of the most widespread races in the highlands of South America. This race has been described and reported by Roberts, et al (17) in Colombia, by Grobman, et al (4) in Peru, by Grant, et al (3) in Venezuela and by Timothy, et al (20) in Ecuador. It is also grown in Guatemala where it is called Serrano, according to Wellhausen, et al (23) and

Roberts, et al (17). Its possible relationships with races such as Nal-Tel and Pollo have already been mentioned above. Although the race Sabanero is not classified in the literature as a primitive race, it has been thought to be of interest in this study because of its widespread distribution and close relationship with several true primitive races.

The purpose of this study has been to determine, whether the relationships among the various primitive races postulated by different investigators on the basis of morphological resemblances, might be more clearly established by a comparison of their chromosome morphology or more specifically through the chromosome knob constitutions.

MATERIALS AND METHODS

The collections used in this study as representative of the different races studied are indicated in Table 1a.

The methods used were the same as those described in the general introductory section of this publication.

RESULTS

The number of plants studied and the results obtained for each collection of each race are given in Tables 2a and 3a and in the Figures 1a through 16a. Also in section B of this publication, Figure 3b, collections of the Nal-Tel race from Yucatán, Mexico, are shown in comparison with those collections of the same race from Guatemala. The situation in regard to chromosome knobsof each of the races studied is presented below:

Nal-Tel. This race has shown an overall average knob number of about 10 knobs per plant. The variation in the knob numbers among the several collections studied was found to be from 8.6 to 12.2 knobs per plant. However, most of the collections have shown knob numbers very close to the mean number of 10.

Regarding the knob-forming positions it was found that there are several positions at which the presence of knobs was very uniform in almost all collections of this race. These positions were: 1Sa, 2L, 3L, 4L, 5L, 6Lb, 6Lc, 7L, 8La, 8Lb, and 9S. The position 9L showed a lower frequency than these, although in few collections from Oaxaca and Guerrero it was knobbed in high frequency. The positions 1L, 2S and 7S were knobbed in very low frequency and the remaining positions, 1Sb, 3S, 4S and 6La were almost knobless. The position 10L was completely knobless, but several collections presented the extra heterochromatic segment of the so-called abnormal chromosome 10.

Table 1-a. Some information of the collections of primitive races of maize studied.

Race	Origin	Collections	Described by
Nal-Tel	Mexico	Yucatan 7, 36, 37, 75, 102, 129, 146 and 148. Campeche 18, 29, 37, 39, 41C, 54, 102 and 103. Chiapas 139 and 144. Oaxaca 148, 171 and 174. Guerrero 17, 100, 121, 168, 174 and 177.	Wellhausen, *et al*. (1952).
	Guatemala	Guat. 20, 145, 164 and 225.	Wellhausen, *et al*. (1957).
	El Salvador	Salv. 9 and 29.	
Chapalote	Mexico	Sinaloa 2 and 6. Sonora 27 and 55.	Wellhausen, *et al*. (1952).
Aragüito	Venezuela	Ven. 678.	Grant, *et al*. (1963).
Guaribero	"	Ven. 459 and 530.	" " "
Sabanero	"	Ven. 558.	Grant, *et al*. (1963) in Venezuela; Timothy, *et al*. (1963) in Ecuador; Grobman, *et al*.(1961) in Peru; Roberts, *et al* (1957) in Colombia.
Canilla	Venezuela	Ven. 513.	Grant, *et al* (1963).
Pollo	Colombia	Cun. 401. Pollo segregaciones (composite of 7 collections, M57A-7708#).	Roberts, *et al* (1957) in Colombia; Grant, *et al* (1963) in Venezuela.
Pira	Colombia	Pira Blanco (composite of 15 collections M57A-7701#).	Roberts, *et al* (1957) in Colombia; Grant, *et al* (1963) in Venezuela.
Maicena A (Pira type)	Costa Rica	C.R. 166 and 379.	Wellhausen (unpublished).
Pororo	Bolivia	Bov. 806.	Ramírez, *et al* (1960).
Enano	Bolivia	Bov. 1143 and 1144.	Ramírez, *et al* (1960) in Bolivia; Grobman, *et al* (1961) in Peru; Timothy, *et al* (1963) in Ecuador.
Palomero Toluqueño	Mexico	Mex. 5, 6, and 211.	Wellhausen, *et al* (1952).
Confite Morocho	Peru	Peru 378 (Aya 4), 685, 887 and 963.	Grobman, *et al* (1961).
Confite Puntiagudo	Peru	Anc. 250.	Grobman, *et al* (1961).
Pisinkalla	Bolivia	Bov. 344, 760 and 864.	Ramírez, *et al* (1960).
Pisinkalla Pororo	Bolivia	Bov. 570, 693 and 780.	" " "
Canguil	Ecuador	Ecu. 396, 413, 443, 447, and 943.	Timothy, *et al* (1963).

Concerning the size of the knobs it was found that in general the large knobs were predominant, although some frequently knobbed positions such as 1Sa, 6Lb and 6Lc and the less frequently knobbed position 9L showed rather small knobs. The particular knob on 8Lb, although very frequent, was in general very small and in most instances was rather a large chromomere.

An interesting fact found in this race is that many of the collections of Mexico have shown a large nucleolar organizer (some in high frequency) which was not found in any of the other primitive races studied with the exception of Guaribero of Venezuela.

Some collections, especially from Yucatan and Campeche of Mexico and the two collections of El Salvador have shown the presence of the supernumerary B-type chromosomes. An interesting fact that should be mentioned in this regard is that several of the collections having B-type chromosomes did not possess the abnormal chromosome 10 and viceversa. Others possessed both types of chromosomes together in the same plant.

<u>Chapalote</u>. This race has shown an overall average knob number of 11.7. Among the two sets of collections of this race studied, the collections from Sonora had a higher average knob number (12.6) than those collections from the State of Sinaloa (10.9). Also, the collections from Sonora varied from 12 to 14 knobs per plant, whereas, those from Sinaloa varied from 10 to 12 knobs per plant.

The knobbed positions in the four collections studied were similar to those of the Nal-Tel race in both knob presence and size.

The abnormal chromosome 10 was not found in any of the four collections of this race studied. However, in the two collections from Sonora, some plants showed a small knob on the long arm of the chromosome 10.

In only one collection, (Son. 55), the B-type chromosomes were present in a fairly high frequency. Four out of five plants examined had this extra chromosome.

<u>Aragüito</u>. This race has shown an average knob number of 11.7, similar to that of Chapalote.

In knobbed positions and knob size it was found to be similar to Nal-Tel and Chapalote, with the main difference in that the collection of Aragüito possessed a large knob in 2S, and 9L in a high frequency.

Neither abnormal chromosome 10 nor B-type chromosomes were found in the six plants of this race examined.

<u>Guaribero.</u> The average knob number obtained from the two collections

of this race studied is 13.1 knobs per plant. This race has a higher knob number than Nal-Tel, Chapalote and Aragüito. With respect to the positions presenting knobs, it is similar to the three races already mentioned. A large nucleolar organizer, characteristic of Nal-Tel was found in one of the two collections of Guaribero (Ven. 530). It differs from these races primarily in that both collections of Guaribero showed a high frequency in the presence of a large knob in the positions 7S and 9L.

Both abnormal chromosome 10 and B-type chromosomes were found, but independently, in the two collections.

Sabanero. The single collection of this race (Ven. 558) has shown an average knob number of 11.2. In knobbed positions and knob size it is similar to collection Ven. 678 of the race Aragüito. These two collections differ from each other only in that the collection of Aragüito possessed B-type chromosomes.

Canilla. Only one collection was studied and it showed an average knob number of 12.2, intermediate between the other Venezuelan races Aragüito, Guaribero and Sabanero. The distribution of the knobs in its chromosomic complement is quite similar to Guaribero.

Neither abnormal chromosome 10 nor B-type chromosomes were found.

Pollo. This race has shown a lower average knob number of 7.1 knobs per plant. Pollo has knobs at the same knob-forming positions as Nal-Tel, but some of these positions in Pollo have shown a knob with a lower frequency, a fact that must have influenced the lowering of the average knob number in Pollo. These positions are mainly 1Sa, 6Lc and 8Lb. Pollo is very similar to Nal-Tel in knob size and like Nal-Tel has a predominance of large knobs in spite of its lower knob number.

Abnormal chromosome 10 and B-type chromosomes were found in a high frequency.

Pira. Its average knob number of 13.2 is similar to that of Guaribero but higher than that shown by Nal-Tel, Chapalote and the other races mentioned above.

In knob positions it differs from Nal-Tel and Chapalote, but is similar to Guaribero and Canilla of Venezuela, in that it possesses a large knob in a high frequency in the positions 2S, 3S, 7S and 9L. In all other respects it is quite similar to Nal-Tel and Chapalote.

The abnormal chromosome 10 and the B-type chromosomes were absent in the sample of this race studied.

Maicena A. The two collections of this race studied were very uniform and showed an average knob number of 14 knobs per plant.

In regard to the knobbed positions and knob size, this race is very similar to Pira Blanco of Colombia. However, there are several differences: Maicena has a medium size knob in a high frequency in 2S; in Pira, the knob in this same position is large in size and of a lower frequency; at 7S, Maicena A showed a small knob in low frequency while in Pira a small knob at this same position is presented at a high frequency.

Abnormal chromosome 10 was present in one collection of Maicena A, although Pira did not possess it.

Pororo. The average knob number of 7.0 knobs per plant obtained by the analysis of a single collection, (Bov. 806), is similar to that found in Pollo of Colombia, but these two races differ in many other respects. In the first place, Pororo has fewer knobbed positions than Pollo, but with more uniform frequency; secondly, Pollo possessed a predominance of large knobs while Pororo had a predominance of small to medium size knobs.

Certainly Pororo is completely different from Pira of Colombia, in both knob positions and knob size. As in the case of Pollo, this race had B-type chromosomes, but no abnormal chromosome 10 was detected.

Enano. This race appears to be a very exclusive type of corn from among the primitive races, from the cytological point of view, all plants examined, except one, possessed two small knobs in only two positions, 6Lc and 7L. A single plant of Bov. 1143 was found to possess two other small knobs in 2L and 8La. B-type chromosomes and abnormal chromosome 10 were absent.

Palomero Toluqueño. Collections of this race have shown quite low knob numbers giving an overall average of 2.1 knobs per plant, similar to that of Enano.

Although the average knob number of Palomero Toluqueño and Enano are similar, they are completely different in knobbed positions. The race Enano is characterized by its uniformity in knob position, size and frequency, while Palomero Toluqueño is more variable. Palomero Toluqueño showed variable sized knobs in very different positions and in quite low frequency.

No abnormal chromosome 10 was found in any of the three collections examined for Palomero Toluqueño.

An interesting fact found in this race was that one of the collections, Mexico 6, presented B-type chromosomes, although the number of knobs per plant was very low; one plant appeared to be knobless but possessed a single B-type chromosome.

Confite Morocho. This race has shown an average knob number of 3.1 knobs per plant with a variation from 1 to 7. However, there were appreciable differences in the number of knobs observed among the three collections examined. Peru 963 had a mean of 5.0, Peru 685 of 3.7 and Peru 378 of 0.8 knobs per plant. This fact shows that different populations within a race can have very different chromosome knob constitutions.

In general, small knobs were predominant in all the three collections of Confite Morocho race examined, although some medium and large knobs were apparent in some positions, especially in 2L of Peru 963.

This race seems to be similar to Palomero Toluqueño of Mexico, Confite Puntiagudo of Peru, Pisinkalla and some collections of Pisinkalla-Pororo of Bolivia. The main differences found between Confite Morocho and Palomero Toluqueño is that the former race had knobs on 6L but the latter race did not show a knob in this chromosome arm.

Collection Peru 378 which showed the lowest knob number possessed some B-type chromosomes. A similar case was found in a collection of Palomero Toluqueño.

Confite Puntiagudo. The average knob number shown by the single collection studied (Anc. 250) was 3.0 with a variation from 2 to 4 knobs per plant. Predominance of small to medium size knobs was the rule. This race is similar to Confite Morocho and to Palomero Toluqueño in knob constitution.

Abnormal chromosome 10 and B-type chromosomes were absent.

Pisinkalla. The average knob number for this race was 3.6 with a variation from 2 to 6 knobs per plant. Predominance of small size knobs was characteristic, but some medium and large size knobs were present.

No abnormal chromosome 10 was present but B-type chromosomes were present in a very high frequency in 2 of the 3 collections studied, Bolivia 344 and 864. The frequency of B-type chromosomes in this race is surprisingly higher than that found in all the collections examined in this study, although Sonora 55 of the Chapalote race was similar in this respect.

The general knob constitution of Pisinkalla is very similar to Confite Morocho and Confite Puntiagudo, and especially to Peru 685 and 963 of the Confite Morocho race.

Pisinkalla - Pororo. The average knob number for this race was 3.8 with a range in the variation from 1 to 7 knobs per plant. The three collections studied showed very different knob constitutions, not only in number but also in the positions which had knobs. Bolivia 570 presented large knobs in 3S which were not found in any of the other two collections of this race. This knob was found only in the collections studied of the Chapalote and Pira races. Another knobbed position of interest in Pisinkalla-Pororo is 1Sa; a knob at this position was present in two collections, Bov. 570 in a high frequency and in Bov. 780 in a low frequency. This knob also was found in two collections of Confite Morocho. It is the same knob found to be prevalent in the races Nal-Tel, Chapalote, Pira, Aragüito, Guaribero, Canilla and Sabanero. Both above mentioned knobs, 3S and 1Sa, were absent in the single collection examined of Pororo.

Another position with a knob of interest is that of 6Lb. This knob was found in two collections, Bov. 570 and 780, of Pisinkalla-Pororo. This knob is also prevalent in the races Nal-Tel, Chapalote, Pira, Aragüito, Guaribero, Canilla, Sabanero and Pororo; and in the races Pollo, Confite Morocho and Pisinkalla at a lower frequency. It was not found in any of the collections studied of the races Palomero Toluqueño, Enano and Canguil.

Canguil. Collections examined of this race have shown the interesting fact, as in the case of Confite Morocho, that within the same race different populations can possess very different knob constitutions, assuming that the racial classification was correctly made. Ecuador 943 showed an average knob number of 8.0 with a variation from 6 to 9 knobs per plant, while Ecuador 396, on the other hand, possessed an average knob number of 1.2 with a variation from 1 to 2 knobs per plant. The other three collections, Ecuador 413, 443 and 447, were intermediate in mean knob numbers.

Small to medium size knobs were predominant, although some large knobs were present. In this respect it is of interest to point out that 9S showed a large knob, especially in Ecuador 943. This large knob was only prevalent in those races having high knob numbers with a predominance of large knobs such as, Nal-Tel, Chapalote, Pira, Pollo, Aragüito, Guaribero, Canilla and Sabanero.

The collection Ecuador 396 which showed the lowest knob number had a knob constitution very similar to the Enano race, differing in that Ecuador 396 had low frequency in the knob on 6Lc while Enano had it in a high frequency.

Abnormal chromosome 10 was present in three plants out of five examined in the collection Ecuador 943. B-type chromosomes were absent in all collections studied for this race.

DISCUSSION

The results obtained from the present study have shown that primitive races of maize vary in their chromosome knob constitutions. However, two general groups or complexes of primitive races can be formed: Group 1 includes those races which have, in general, a high knob number with a predominance of the large size knobs. To this group belong the races Nal-Tel, Chapalote, Pira, Maicena A, Pollo, Guaribero, Canilla, Aragüito and Sabanero. Group 2 comprises those races which have, in general, low knob numbers with a predominance of the small size knobs. Races belonging to this group are: Palomero Toluqueño, Confite Morocho, Confite Puntiagudo, Pisinkalla, Pisinkalla-Pororo, Pororo, Canguil and Enano.

If McClintock's criteria, reported in Ramírez, et al (15), Timothy, et al, (20) and McClintock (9) is followed in the sense that particular knobs at fixed positions in the chromosome complement can indicate relationships between races of maize, it is possible to draw out some specific relationships between the several primitive races within each of the two groups already mentioned, and also some relationships between these two groups.

Within the first group the two races that seem to be most distinct are Nal-Tel and Pira. Although both have in common knobs on 1Sa, 2L, 3L, 4L, 5L, 6Lb, 6Lc, 7L, 8La, 8Lb and 9S, they are different in that Pira possesses large knobs on 2S, 3S, 7S and 9L which are not characteristic knobs in Nal-Tel. However, some collections of Nal-Tel from Southern Mexico and Central America presented these knobbed positions. They may indicate an introgression of Pira or its close relative Maicena A into Nal-Tel.

Chapalote which is restricted to the Northwestern region of Mexico, has shown two interesting facts: (1) some collections such as, Sonora 27 and 55 are very similar to Pira in regard to the knobs 2S, 3S and 7S, but different from it in regard to the position 9L, which is present in Pira but absent in Chapalote; and (2) the two collections of the Chapalote race from Sinaloa were in all knobbed positions characteristically Nal-Tel type.

The Venezuelan races Aragüito, Canilla, Guaribero and Sabanero studied appear to be similar to Pira in that, like this race, they possess knobs on 2S, 7S and 9L, but at the same time similar to Nal-Tel in the absence of knobs on 3S and in the case of Guaribero on 2S. One collection of Guaribero is similar to the Nal-Tel race in that it has a large nucleolar organizer.

The relationship with Maicena A is similar to that with Pira. Maicena A, however, possessed a knob on 4S not present in Pira, very rarely found in Nal-Tel and found in one collection of Guaribero. This knob must represent an introgression to these races from some unknown source.

Pollo in most of its knobs is similar to Nal-Tel although a knob on 9L, characteristic of Pira, is present.

At the present time it is not possible to determine whether all the races of this complex have been derived from a common source or not, but at least one fact is clear: namely that Nal-Tel and Pira possess two somewhat different knob constitutions and could have given rise, through their reciprocal introgressions, to many of the other primitive races of maize in Mexico, Central America and the Northern part of South America. Among the primitive races that could have originated in this way are Chapalote, Pollo, Aragüito, Guaribero, Canilla and Sabanero. All of these appear to be in some way related to both Nal-Tel and Pira. On the basis of this study the Chapalote - Nal-Tel - Pollo complex of races mentioned by Wellhausen, et al (21, 23) probably should be enlarged to include the Pira race.

The cytological studies of South American races made by McClintock and reported by Ramírez, et al (15) and by Timothy, et al (20) indicate that in the highlands of that region a basic chromosome knob constitution exists which consists of a chromosome complement possessing only two small knobs on 6Lc and 7L. This knob constitution has been called by her as the "Andean" pattern of knob constitution. The race Enano was reported as one of the races having this characteristic "Andean" pattern. In the present study this same Enano race of Bolivia has shown, as expected, the knob constitution of the "Andean" type.

Confite Morocho appears to be a variable race since two of the three collections examined had a relatively higher number of knobbed positions than the third, Peru 378 also known as Ayacucho 4. This latter collection was almost knobless, and probably it represents another "Andean" pattern of chromosomic constitution; namely, that of a completely knobless one, which in some places has been maintained with little or no introgression at all from a knobbed type of maize.

Although one of the collections of Confite Morocho, Peru 963 had consistently present the characteristic knobs of the McClintock's "Andean" pattern, it shows clearly other knobs, especially on 2L which presented some large knobs, which indicate a relationship with some maize type of the Nal-Tel - Pira complex.

The single collection of the Confite Puntiagudo, Ancachino 250, showed much similarity to the highly knobbed collections of Confite Morocho.

Pisinkalla also has been shown to be similar to the highly knobbed collections of Confite Morocho. However, two of the collections, Bolivia 344 and 864, presented an extremely high number of B-type chromosomes, the origin of which is difficult to explain with the present data.

Pisinkalla-Pororo as in the case of Confite Morocho, showed a great variability in the knob constitutions among different collections. Bolivia 693 with a low knob number could have originated from the inter-crossing of McClintock's "Andean" type and the knobless type maize, since it showed consistently the characteristic knob on 7L, but with the knob on 6Lc in a very low frequency.

The collection Bolivia 570 of Pisinkalla-Pororo possessed two knobs in two positions, 1Sa and 3S. Some of these knobs were of large size. This indicates clearly its relationship to the Pira type, since the large knob on 3S was only encountered in a sample of the Pira race. The same collection, Bolivia 570, also shows a direct relationship to the Pororo race. In this collection, four of the knobs, 5L, 6Lb, 6Lc and 7L are very similar to the knobs at the same positions in Pororo.

The single collection of Pororo race examined was very uniform in its chromosome morphology. It resembles Pollo or Nal-Tel in its knobbed positions, 2L, 3L, 5L, 6Lb, 6Lc, 7L and 9L, but differs from them in that the small to medium size knobs are predominant in Pororo, whereas, the large size knob predominates in Nal-Tel and Pollo.

One collection of the Canguil race, Ecuador 396, with its almost knobless constitution, indicates again, as in the case of Confite Morocho and Pisinkalla-Pororo, that in the Andean region of South America there exists a knobless type of maize which may have been basic in the evolution of maize in these highland regions.

The presence in this collection of a small knob in a high frequency in 7L could indicate that it has a relationship to the McClintock's "Andean" type of maize.

The other four collections of the Canguil race show introgression from a highly knobbed type of maize. The presence of several large knobs in different positions, but especially on 9S, indicates that probably the introgression came from the Nal-Tel-Pira complex of races.

The three collections of Palomero Toluqueño studied, indicate again that the knobless type of maize was the basic material in the formation of this race. In general, it is quite similar to Confite Morocho or Pisinkalla, but at the present it is not possible to determine if the Palomero Toluqueño of Mexico represents an early introduction from South America or whether it was evolved directly in Mexico and its counterparts in South America derived from it.

McClintock (9) has reported a collection of Palomero Toluqueño that possessed a high number of large knobs, a fact that is completely different from the results obtained in the present study. Also the results obtained for the single collection studied of Sabanero which showed a high number of large knobs, differ completely from the results reported for the same race in South America by Roberts, et al (17) in Colombia and by Timothy, et al (20) in Ecuador. They reported extremely low knob numbers and in Ecuador, Sabanero is placed among the McClintock's "Andean" type of maize. Probably the Canguil race, discussed above, is similar to this case but in an intermediate state. All these facts clearly demonstrate that the same race can have populations with completely different chromosome knob constitutions or the collections have been incorrectly classified. Moreover, they indicate that different populations of a given race of any of the two above mentioned groups, can have introgression in very different degrees from races of the other group depending upon the specific circumstances under which they have met.

From the results obtained in the present study, it can be noticed that any knob position varies between plants of any collection not only in the frequency with which it is present, but also in its size. Any position can be present without a knob, or with a small, medium or large size knob. In discussing all these facts, one question arises. What are the origins of the differences in knob sizes found at different knob-forming positions?

Taking into consideration that, as Mangelsdorf and Reeves (13) have postulated, chromosome knobs of maize have their origin in Tripsacum, the above question is not answered, since the same problem would be met in the genus Tripsacum. One idea that answers the above question is that postulated by McClintock (9) in the sense that maize has had several centers of origin and that in each center different chromosome knob constitutions evolved. However, this idea needs to be demonstrated. There is a possibility that an internal process exists by means of which knobs would have the capacity of changing in size and shape.

Actually, nobody knows the real process or processes by which this variation in the knobs have originated in maize populations. It appears that some kind of process other than hybridization is responsible in bringing about knob size polymorphism in maize. This fundamental problem must be clarified in future studies.

The presence of the abnormal chromosome 10 in some of the collections studied seems to indicate that it is not necessarily dependent on the presence of the B-type chromosomes. This is indicated by the fact that some collections had abnormal chromosome 10 but not B-type chromosomes and viceversa; others had both types of chromosomes, even in the same plant.

Furthermore, the presence of B-type chromosomes can be completely independent from the presence of knobs, since in Palomero Toluqueño plants without knobs but with B-type chromosomes were found.

Table 2a.- Data showing, for the various collections of some primitive Mexican, Central and South American races of maize, the number of chromosome knobs at the 20 knob forming positions. Collections from each place are arranged in a descending order for the number of knobs present.

Collection No. and Country	Mean Knob No.	No. of Plants	Number of knobs at the 20 knob forming positions 1S a	1S b	1L	2S	2L	3S	3L	4S	4L	5L	6S	6L a	6L b	6L c	7S	7L	8L a	8L b	9S	9L	10L	Plants with ab 10	Total No. ab 10	Plants with BT	Total No. BT
Mexico																											
Yucatan 129	11.0	5	4	-	1	-	5	-	5	-	5	5	1La	-	5	5	-	5	5	5	5	-	-	-	-	-	-
146	10.5	4	4	-	-	-	4	-	3	-	4	4	X	-	4	4	-	4	4	4	3	-	-	-	-	-	-
36	10.2	5	1	-	-	-	5	-	3	-	5	5	X	-	5	5	1	5	4	4	4	4	-	-	-	-	-
37	10.2	4	4	-	-	-	4	-	2	-	4	4	X	-	4	4	-	4	4	4	1	2	-	-	-	-	-
75	10.2	5	5	-	-	1	5	-	1	-	5	5	X	-	5	5	-	5	5	5	1	3	-	1	2	-	-
148	10.2	5	1	-	-	-	5	-	5	-	5	5	X	-	5	5	-	5	5	5	5	-	-	4	6	3	4
7	9.8	13	9	-	-	2	12	-	10	-	13	13	4La	-	8	13	4	13	6	12	13	-	-	-	-	2	4
102	9.6	5	3	-	-	1	3	-	3	-	5	5	X	-	5	5	-	5	3	5	5	-	-	-	-	-	-
Campeche 102	11.1	10	9	-	-	1	10	-	8	-	10	9	X	-	10	9	2	10	9	10	9	5	-	-	-	-	-
18	10.6	5	3	-	-	-	4	-	5	1	5	5	X	-	5	5	-	5	5	5	5	-	-	-	-	5	6
39	10.0	5	4	-	1	1	4	-	3	-	5	5	X	-	5	5	-	5	5	5	2	-	-	-	-	-	-
54	10.0	6	4	-	-	1	4	-	6	-	6	6	1La	-	5	5	-	6	5	6	5	1	-	-	-	4	4
103	10.0	7	4	-	-	-	7	-	7	-	7	7	5La	-	7	7	-	7	5	7	5	-	-	-	-	5	13
41C	9.8	5	4	-	-	-	5	-	3	-	5	5	1La	-	5	5	-	5	3	5	3	1	-	-	-	-	-
29	9.0	5	1	-	1	-	5	-	1	-	5	5	X	-	3	5	2	5	3	3	5	1	-	-	-	-	-
37	8.6	5	1	-	-	1	5	-	4	-	4	5	X	-	5	5	-	5	2	5	1	-	-	-	-	-	-
Chiapas 144	10.8	5	5	-	-	-	5	-	5	-	5	5	3Sm	-	5	5	-	5	4	5	5	-	-	-	-	-	-
139	10.4	5	-	-	1	-	4	-	5	-	5	5	X	-	5	5	3	5	4	5	4	1	-	1	1	-	-
Oaxaca 171	12.2	5	4	-	-	-	5	-	5	4	5	5	X	-	5	4	-	5	5	5	4	5	-	-	-	-	-
174	11.0	5	4	-	-	-	5	-	5	-	5	5	X	-	4	3	-	5	5	5	5	4	-	-	-	-	-
148	10.9	11	8	-	-	2	11	1	11	-	11	11	1La	-	6	10	-	11	8	10	11	9	-	2	2	-	-
Guerrero 174	11.1	9	7	-	-	-	9	3	5	-	9	9	1La	3	7	9	2	9	8	9	6	5	-	-	-	-	-
121	10.2	5	2	-	-	-	5	-	4	-	5	5	2La	-	5	4	-	5	5	5	5	1	-	1	1	1	2
100	9.6	5	4	-	4	-	3	-	-	-	5	3	X	-	5	4	-	5	4	4	5	2	-	-	-	-	-
168	9.6	5	3	-	-	-	5	-	3	-	4	5	X	-	4	5	-	5	5	5	4	-	-	-	-	-	-
17	9.5	4	4	2	-	-	4	-	2	-	4	3	X	-	3	-	1	4	4	3	3	1	-	1	1	-	-
177	9.2	5	2	-	-	-	4	-	3	-	5	5	X	-	4	5	1	5	4	4	2	2	-	-	-	-	-
Sonora 27	12.6	5	4	-	-	2	5	-	5	-	5	5	X	-	5	5	5	5	5	5	5	-	2	-	-	-	-
55	12.6	5	5	-	-	3	5	4	5	1	5	4	X	-	5	5	-	5	5	5	5	-	1	-	-	4	9
Sinaloa 2	11.0	5	5	-	-	-	5	-	5	-	5	5	X	-	2	5	3	5	5	5	5	-	-	-	-	-	-
6	10.8	5	5	-	-	1	5	-	5	-	5	5	X	-	4	5	-	5	5	4	5	-	-	-	-	-	-
Mexico 211	2.4	5	-	-	-	2	2	-	2	-	-	4	X	-	-	-	-	2	-	-	-	-	-	-	-	-	-
5	2.2	5	-	-	-	-	1	-	-	-	2	4	X	-	-	-	-	1	1	-	1	-	-	-	-	-	-
6	1.6	5	-	-	-	-	-	-	1	-	-	2	X	-	-	-	-	1	-	-	-	2	2	-	-	4	5
Guatemala																											
20	11.5	2	2	-	1	2	2	-	2	-	2	2	X	-	1	2	-	2	2	-	1	2	-	-	-	-	-
145	12.0	5	5	-	-	-	5	-	5	-	5	5	X	-	5	5	2	5	5	5	5	2	-	1	1	-	-
164	12.0	2	2	-	-	1	2	-	2	-	2	2	X	-	2	2	-	2	2	-	2	2	1	1	1	-	-
225	10.0	2	2	-	-	-	2	-	2	-	2	2	X	-	2	2	-	2	2	2	-	-	-	-	-	-	-

Collection No. and Country	Mean Knob No.	No. of Plants	1S a	1S b	1L	2S	2L	3S	3L	4S	4L	5L	6S	6L a	6L b	6L c	7S	7L	8L a	8L b	9S	9L	10L	Plants with ab 10	Total No. ab 10	Plants with BT	Total No. BT
			Number of knobs at the 20 knob forming positions																								
El Salvador																											
9	12.0	5	4	-	2	4	5	-	5	-	5	5	X	-	4	5	-	4	5	5	5	2	-	2	2	1	1
29	11.4	5	3	-	1	4	3	2	5	-	5	5	X	-	5	3	-	5	5	5	5	1	-	-	-	2	3
Costa Rica																											
166	14.0	5	5	-	1	5	4	4	5	2	5	5	X	-	5	5	1	5	5	5	4	4	-	2	2	-	-
379	14.0	5	5	-	1	5	5	3	5	1	5	5	X	-	5	5	-	5	5	5	4	5	1	-	-	-	-
Colombia																											
Pira Blanco	13.2	6	6	-	1	1	6	3	6	-	6	6	X	-	6	4	6	6	6	5	5	6	-	-	-	-	-
Cun. 401	7.4	10	1	-	-	1	10	-	9	-	8	6	X	1	5	3	-	10	8	1	8	4	-	6	7	2	5
Pollo Segr.	6.8	5	3	-	-	-	4	-	4	-	5	3	X	-	3	1	-	5	2	-	4	-	-	-	-	5	12
Venezuela																											
459	13.2	5	4	-	1	-	5	1	5	2	5	5	X	2	5	2	5	5	5	4	5	5	-	1	1	-	-
530	13.0	4	4	-	-	-	4	-	4	-	4	4	1La	-	4	4	4	4	4	4	4	4	-	-	-	1	1
513	12.2	5	5	-	-	1	5	-	5	-	5	5	X	-	5	5	4	5	5	3	5	3	-	-	-	-	-
678	11.7	6	5	-	-	6	-	-	5	-	5	6	X	2	6	5	2	6	6	4	5	6	-	-	-	-	-
558	11.2	5	4	-	1	5	-	-	5	-	5	5	X	-	5	3	2	5	4	2	5	5	-	-	-	3	6
Ecuador																											
943	8.0	7	-	-	-	-	7	-	7	-	6	6	X	2	1	5	-	6	2	-	7	7	-	-	-	-	-
447	5.2	5	-	-	-	-	4	-	4	-	4	4	X	-	-	2	-	5	-	-	3	-	-	-	-	-	-
443	4.8	5	-	-	-	-	1	-	4	-	3	3	X	-	-	3	-	5	-	-	2	3	-	-	-	-	-
413	4.8	4	-	-	-	2	1	-	1	-	1	4	X	-	-	2	-	4	-	-	4	-	-	-	-	-	-
396	1.2	6	-	-	-	-	1	-	-	-	-	-	X	-	-	1	-	5	-	-	-	-	-	-	-	-	-
Bolivia																											
806	7.0	5	-	-	-	1	5	-	5	-	1	5	X	-	5	5	-	5	-	-	3	-	-	-	-	1	2
570	6.6	6	6	-	-	-	1	5	-	-	1	5	X	-	5	5	-	5	-	-	-	-	-	-	-	-	-
344	5.0	5	-	-	-	-	3	-	-	-	3	5	X	-	4	3	-	5	-	1	1	-	-	-	-	4	12
780	4.2	5	1	-	-	3	5	1	-	-	-	3	X	-	2	-	-	4	-	-	2	-	-	-	-	-	-
864	3.0	4	-	-	-	-	3	-	-	-	3	1	X	-	-	1	-	3	-	-	1	-	-	-	-	3	14
760	3.0	5	-	-	-	-	4	-	1	-	2	3	X	-	-	-	-	5	-	-	-	-	-	-	-	-	-
1143	2.4	5	-	-	-	-	1	-	-	-	-	-	X	-	-	5	-	5	1	-	-	-	-	-	-	-	-
1144	2.0	5	-	-	-	-	-	-	-	-	-	-	X	-	-	5	-	5	-	-	-	-	-	-	-	-	-
693	1.8	5	-	-	-	-	-	-	-	-	-	2	X	-	-	1	-	5	-	-	1	-	-	-	-	-	-
Peru																											
963	5.0	6	2	-	-	-	5	-	-	-	3	2	X	-	6	-	-	6	1	-	4	1	-	-	-	-	-
685	3.7	6	3	-	-	-	4	-	-	-	1	3	X	-	3	-	-	5	-	1	2	-	-	-	-	-	-
Anc. 250	3.0	4	-	-	-	-	1	-	-	-	2	2	X	-	-	-	-	3	-	-	4	-	-	-	-	-	-
378	0.8	5	-	-	-	-	-	-	-	-	-	1	X	-	-	1	-	2	-	-	-	-	-	-	-	2	3
Argentina																											
481	3.6	5	-	-	-	-	1	-	1	-	2	4	X	-	1	5	-	5	-	-	-	-	-	-	-	1	2
Pakistan																											
-	4.6	5	2	-	-	-	5	-	4	-	-	1	X	-	2	2	-	5	-	-	1	1	-	-	-	1	1

Table 3a.- Data from the various collections of some primitive Mexican, Central and South American races of maize, arranged in the order shown in Table 2a and showing mean knob volumes (0-5) at each of the 20 knob-forming positions.

Collection No. and Country		The mean volume of knobs at 20 knob-forming positions																				Mean Knob Volume
		1S a	1S b	1L	2S	2L	3S	3L	4S	4L	5L	6L a	6L b	6L c	7S	7L	8L a	8L b	9S	9L	10L	
Mexico																						
Yucatan	129	2.00	-	2.00	-	3.60	-	4.00	-	4.40	3.40	-	2.20	2.00	-	4.80	3.20	1.20	5.00	-	-	33.08
	146	2.00	-	-	-	3.25	-	2.66	-	4.75	2.50	-	2.00	1.75	-	4.00	4.50	1.00	4.66	-	-	30.60
	36	2.00	-	-	-	3.20	-	2.66	-	4.60	2.60	-	2.00	1.00	1.00	4.20	2.00	1.00	4.50	2.00	-	27.40
	37	2.00	-	-	-	3.25	-	3.00	-	4.00	3.00	-	2.00	1.50	-	3.50	4.00	1.00	2.00	3.50	-	28.00
	75	2.00	-	-	3.00	3.00	-	2.00	-	5.00	2.80	-	2.00	1.00	-	4.00	2.20	1.00	5.00	1.33	-	26.00
	148	2.00	-	-	-	4.40	-	4.20	-	4.80	2.80	-	2.20	1.00	-	4.80	4.40	2.00	4.00	-	-	35.00
	7	2.33	-	-	3.00	3.33	-	3.60	-	5.00	3.23	-	2.25	1.23	1.75	4.15	2.67	1.50	4.00	-	-	30.15
	102	2.00	-	-	2.00	2.66	-	2.66	-	4.40	2.20	-	2.00	1.20	-	4.60	3.66	1.00	2.80	-	-	25.80
Campeche	102	1.88	-	-	3.00	4.00	-	3.50	-	4.80	3.11	-	1.80	1.44	2.00	4.30	2.89	1.40	4.00	2.00	-	32.70
	18	1.33	-	-	-	4.50	-	3.20	1.00	4.00	2.60	-	2.00	1.00	-	3.60	3.20	1.00	4.20	-	-	29.40
	39	2.25	-	1.00	1.00	4.75	-	2.66	-	4.60	3.20	-	2.00	1.00	-	3.40	4.00	1.00	2.00	-	-	27.60
	54	1.50	-	-	2.00	2.75	-	3.50	-	4.00	2.66	-	1.80	1.00	-	4.17	1.40	1.00	4.40	1.00	-	26.70
	103	2.00	-	-	-	4.29	-	3.43	-	3.86	2.43	-	2.29	1.86	-	4.57	2.40	1.14	3.60	-	-	29.28
	410	2.00	-	-	-	3.00	-	3.33	-	4.80	2.80	-	1.60	1.00	-	4.80	5.00	1.00	2.66	2.00	-	27.60
	29	2.00	-	2.00	-	3.80	-	2.00	-	4.80	3.40	-	2.00	1.20	2.00	3.00	2.33	1.00	3.40	3.00	-	23.80
	37	2.00	-	-	2.00	4.00	-	3.00	-	4.00	3.60	-	1.20	1.40	-	3.80	2.50	1.00	3.00	-	-	22.80
Chiapas	144	2.00	-	-	-	2.80	-	2.80	-	4.20	3.20	-	1.40	1.20	-	4.60	3.75	1.00	2.40	-	-	28.60
	139	-	-	2.00	-	4.75	-	2.00	-	4.40	2.80	-	2.00	1.20	2.00	4.00	1.00	1.00	3.25	2.00	-	26.60
Oaxaca	171	2.00	-	-	-	4.40	-	4.20	2.00	4.60	3.60	-	2.00	1.50	-	5.00	3.60	1.00	3.25	2.60	-	39.40
	174	2.00	-	-	-	3.40	-	3.20	-	4.40	3.40	-	2.00	2.33	-	3.60	4.00	1.00	4.80	1.00	-	31.57
	148	2.25	-	-	3.00	3.55	3.00	3.82	-	4.17	2.36	-	2.00	1.90	-	4.27	3.00	1.20	4.55	2.77	-	33.82
Guerrero	174	2.00	-	-	-	4.00	3.00	4.20	-	4.89	1.77	3.33	1.86	2.11	2.00	4.78	2.75	1.11	3.83	2.80	-	33.66
	121	2.00	-	-	-	3.80	-	3.50	-	5.00	4.00	-	2.60	2.25	-	4.60	4.60	1.00	4.80	2.00	-	34.80
	100	1.75	-	2.00	-	2.00	-	-	-	4.00	2.00	-	1.80	1.50	-	4.20	4.25	1.00	4.80	2.00	-	26.20
	168	1.33	-	-	-	4.00	-	4.00	-	3.75	3.60	-	2.00	1.40	-	4.60	2.40	1.60	2.00	-	-	28.20
	17	2.25	1.00	-	-	3.50	-	3.00	-	4.25	2.33	-	2.00	-	2.00	3.00	2.00	1.00	3.66	3.00	-	24.50
	177	2.50	-	-	-	4.25	-	2.66	-	4.40	2.80	-	1.50	1.80	5.00	3.20	3.50	1.50	3.50	3.00	-	26.80
Sonora	27	2.75	-	-	5.00	3.60	-	4.00	-	4.80	4.20	-	1.20	2.20	2.20	4.40	4.40	1.00	5.00	-	1.00	41.80
	55	2.00	-	-	3.00	3.60	2.50	4.40	4.00	4.60	2.25	-	2.00	2.60	-	4.80	3.80	1.40	4.20	-	1.00	40.40
Sinaloa	2	2.20	-	-	-	4.40	-	5.00	-	5.00	3.20	-	2.00	1.60	2.33	4.40	4.60	1.40	4.60	-	-	38.00
	6	2.40	-	-	3.00	4.40	-	3.80	-	4.60	3.00	-	1.50	2.20	-	4.40	3.60	1.00	4.80	-	-	35.80
Mexico	211	-	-	-	1.00	2.50	-	2.00	-	-	2.75	-	-	-	-	3.50	-	-	-	-	-	6.20
	5	-	-	-	-	4.00	-	-	-	2.50	2.75	-	-	-	-	3.00	4.00	-	2.00	-	-	6.20
	6	-	-	-	-	-	-	2.00	-	-	2.00	-	-	-	-	2.00	-	-	-	3.00	1.00	3.20
Guatemala																						
	20	2.00	-	2.00	3.00	5.00	-	3.00	-	5.00	3.00	-	2.00	2.50	-	4.00	2.50	-	4.00	2.00	-	36.00
	145	2.40	-	-	-	5.00	-	5.00	-	5.00	3.60	-	3.20	1.80	2.20	4.80	4.20	1.20	5.00	4.00	-	45.00
	164	2.00	-	-	2.00	3.00	-	4.50	-	4.00	2.50	-	1.50	1.50	-	4.50	2.50	-	4.50	3.00	1.00	33.00
	225	2.50	-	-	-	4.00	-	4.50	-	3.50	2.50	-	2.00	1.00	-	2.50	4.00	1.00	-	-	-	27.50

Collection No. and Country	The mean volume of knobs at 20 knob-forming positions																				Mean Knob Volume
	1S a	1S b	1L	2S	2L	3S	3L	4S	4L	5L	6L a	6L b	6L c	7S	7L	8L a	8L b	9S	9L	10L	
El Salvador																					
9	3.00	-	2.00	4.25	4.80	-	4.80	-	4.80	4.60	-	2.75	2.25	-	5.00	4.80	2.00	5.00	4.00	-	50.00
29	2.00	-	3.00	4.50	4.00	2.00	4.60	-	4.60	4.40	-	2.40	1.67	-	5.00	4.60	2.00	5.00	2.00	-	41.60
Costa Rica																					
166	2.60	-	2.00	3.80	3.50	3.25	5.00	2.00	4.60	3.60	-	1.80	1.20	2.00	4.40	3.40	1.00	4.50	3.00	-	44.00
379	2.20	-	2.00	2.80	2.80	3.33	3.00	2.00	3.60	2.60	-	2.00	1.60	-	4.00	3.00	1.00	4.50	1.80	2.00	37.20
Colombia																					
Pira Blanco	2.67	-	2.00	5.00	4.83	5.00	5.00	-	4.50	4.67	-	4.00	3.25	2.00	4.83	5.00	2.20	4.40	4.33	-	53.40
Cun. 401	2.00	-	-	5.00	4.30	-	5.00	-	3.50	3.17	2.00	2.00	2.00	-	5.00	4.28	1.00	4.12	3.75	-	28.60
Pollo Segr.	1.67	-	-	-	4.50	-	5.00	-	4.60	3.67	-	1.67	1.00	-	4.80	3.00	-	4.25	-	-	26.00
Venezuela																					
459	2.00	-	2.00	-	5.00	3.00	4.60	2.50	5.00	3.80	2.50	2.60	1.50	4.80	5.00	4.40	2.00	4.20	4.00	-	50.20
530	2.00	-	-	-	3.50	-	4.25	-	4.50	3.25	-	2.25	1.50	4.00	5.00	4.00	1.50	4.75	2.50	-	43.00
513	2.00	-	-	5.00	4.20	-	4.80	-	4.60	3.20	-	1.60	2.00	3.00	4.20	4.40	2.00	5.00	4.67	-	43.40
678	1.83	-	-	4.50	-	-	4.60	-	4.50	3.50	4.50	4.17	2.80	2.50	4.67	5.00	1.00	4.60	4.33	-	45.70
558	2.50	-	2.00	5.00	-	-	5.00	-	4.60	3.20	-	3.00	1.67	4.00	4.60	5.00	1.00	5.00	4.80	-	45.20
Ecuador																					
943	-	-	-	-	2.86	-	3.29	-	2.33	2.17	3.50	1.00	2.00	-	1.67	2.00	-	4.86	3.00	-	21.20
447	-	-	-	-	2.75	-	3.25	-	2.75	1.50	-	-	1.00	-	2.40	-	-	2.67	-	-	12.60
443	-	-	-	-	2.00	-	3.25	-	3.00	1.33	-	-	1.00	-	1.40	-	-	5.00	3.67	-	11.60
413	-	-	-	2.00	2.00	-	3.00	-	3.00	2.25	-	-	1.50	-	2.00	-	-	2.25	-	-	10.20
396	-	-	-	-	2.00	-	-	-	-	-	-	-	1.00	-	2.00	-	-	-	-	-	2.10
Bolivia																					
806	-	-	-	2.00	2.40	-	3.00	-	2.00	1.60	-	2.00	1.60	-	2.60	-	-	1.33	-	-	14.80
570	2.67	-	-	-	4.00	4.80	-	-	3.00	2.00	-	2.20	1.00	-	3.00	-	-	-	-	-	14.50
344	-	-	-	-	3.67	-	-	-	2.67	2.20	-	1.25	2.00	-	2.00	-	1.00	1.00	-	-	11.20
780	2.00	-	-	2.33	2.60	3.00	-	-	-	2.00	-	2.00	-	-	2.25	-	-	2.00	-	-	9.60
864	-	-	-	-	2.33	-	-	-	2.33	1.00	-	-	2.00	-	2.00	-	-	2.00	-	-	6.20
760	-	-	-	-	2.00	-	2.00	-	2.00	2.00	-	-	-	-	1.40	-	-	-	-	-	5.40
1143	-	-	-	-	2.00	-	-	-	-	-	-	-	1.00	-	2.00	2.00	-	-	-	-	3.80
1144	-	-	-	-	-	-	-	-	-	-	-	-	1.00	-	1.00	-	-	-	-	-	2.00
693	-	-	-	-	-	-	-	-	-	2.00	-	-	2.00	-	1.60	-	-	3.00	-	-	3.40
Peru																					
963	1.00	-	-	-	4.00	-	-	-	1.67	1.50	-	1.00	-	-	2.00	2.00	-	2.00	1.00	-	9.60
685	1.00	-	-	-	2.75	-	-	-	2.00	2.67	-	1.00	-	-	1.80	-	1.00	1.00	-	-	6.50
Anc. 250	-	-	-	-	3.00	-	-	-	2.00	2.00	-	-	-	-	2.33	-	-	1.00	-	-	5.00
378	-	-	-	-	-	-	-	-	-	2.00	-	-	1.00	-	2.00	-	-	-	-	1.50	1.40
Argentina																					
481	-	-	-	-	2.00	-	1.00	-	4.00	1.50	-	1.00	2.00	-	2.00	-	-	-	-	-	7.20
Pakistan																					
-	2.00	-	-	-	2.40	-	3.25	-	-	1.00	-	1.00	1.00	-	2.40	-	-	4.00	4.00	-	10.40

Figure 1a. Diagram showing mean knob number and the knob number variation (mid-line) for corn collections of the Chapalote race.

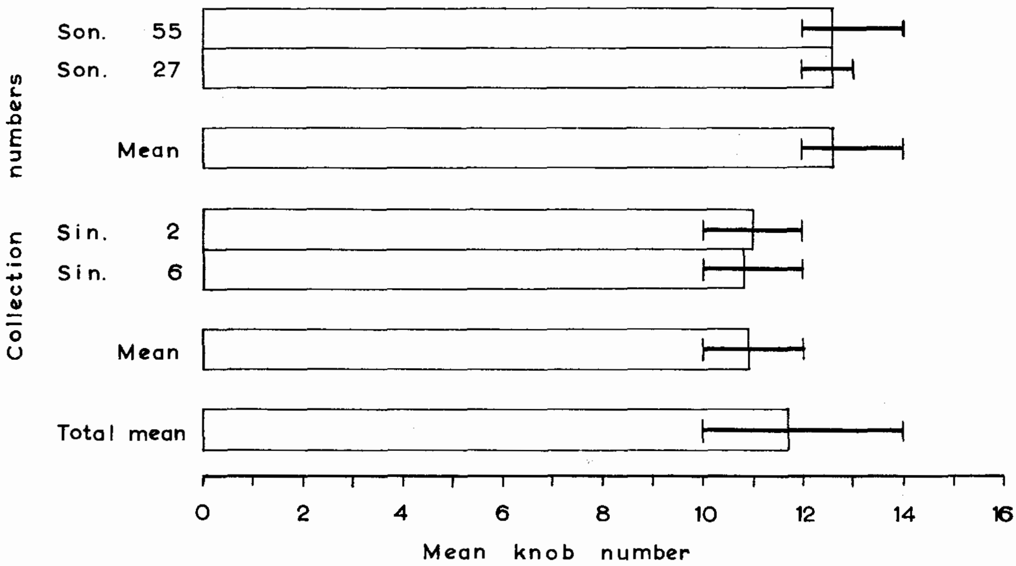


Figure 2a. Diagram showing mean knob number and the knob number variation (mid-line) for corn collections of the Palomero Toluqueño race.

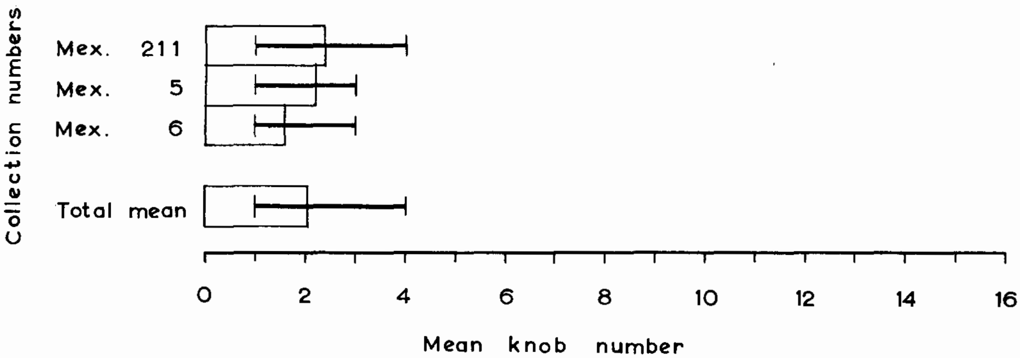


Figure 3a. Diagram showing mean knob number and the knob number variation (mid-line) for corn collections of the Nal-tel race from Campeche, Mexico.

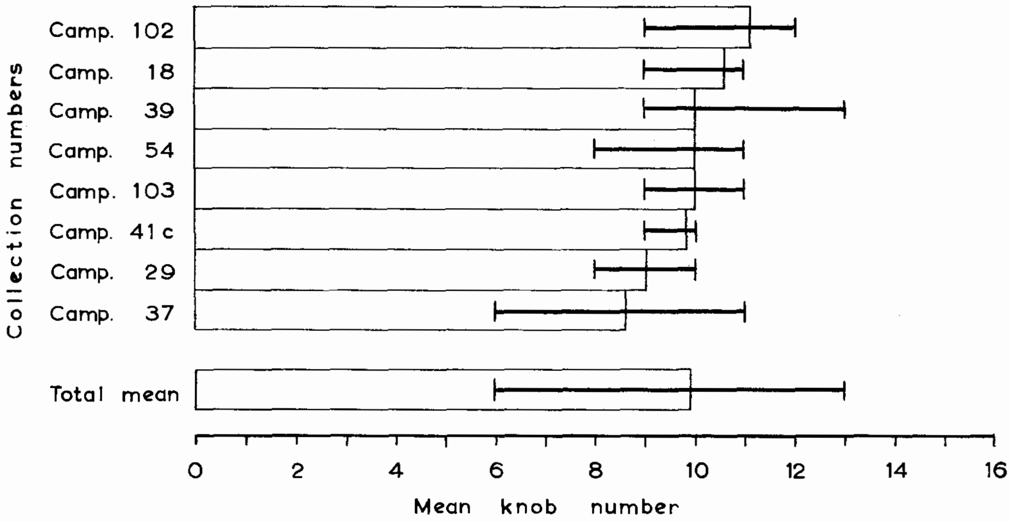


Figure 4a. Diagram showing mean knob number and the knob number variation (mid-line) for corn collections of the Nal-tel race from Chiapas, Mexico.

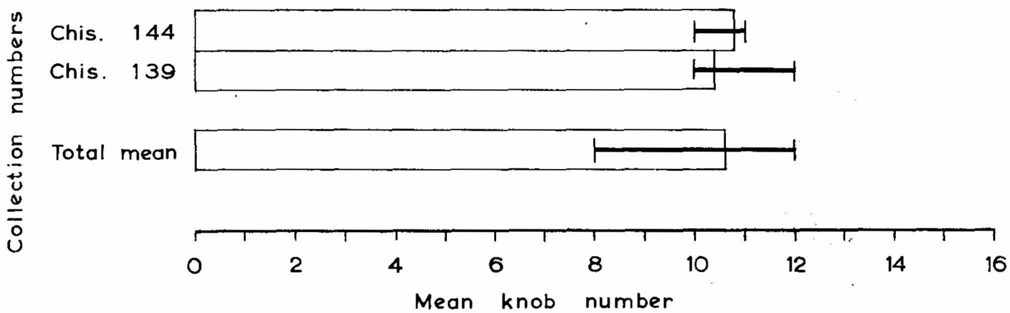


Figure 5a. Diagram showing mean knob number and the knob number variation (mid-line) for corn collections of the Nal-tel race from Oaxaca, Mexico.

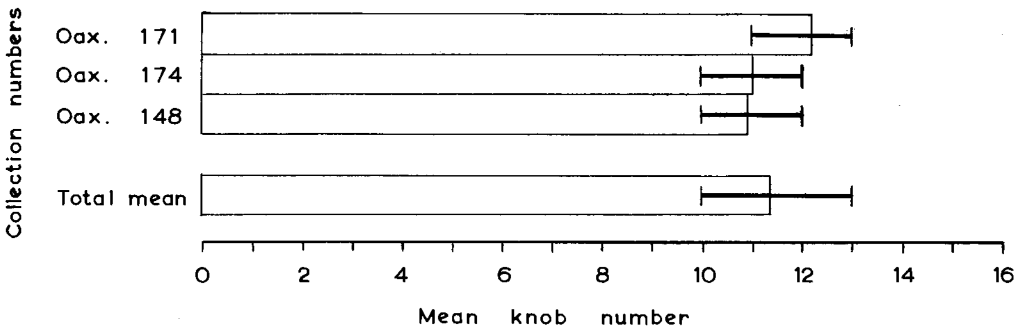


Figure 6a. Diagram showing mean knob number and the knob number variation (mid-line) for corn collections of the Nal-tel race from Guerrero, Mexico.

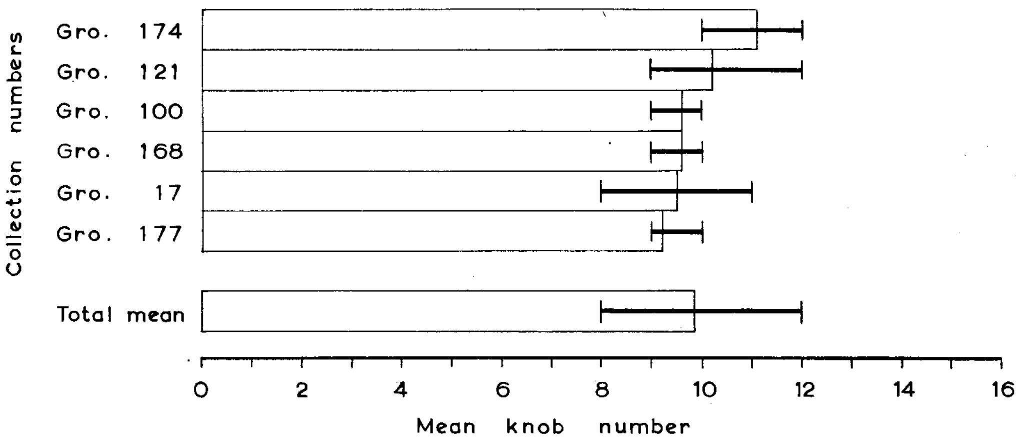


Figure 7a. Diagram showing mean knob number and the knob number variation (mid-line) for corn collections of the Nal-tel race from Yucatán, Mexico.

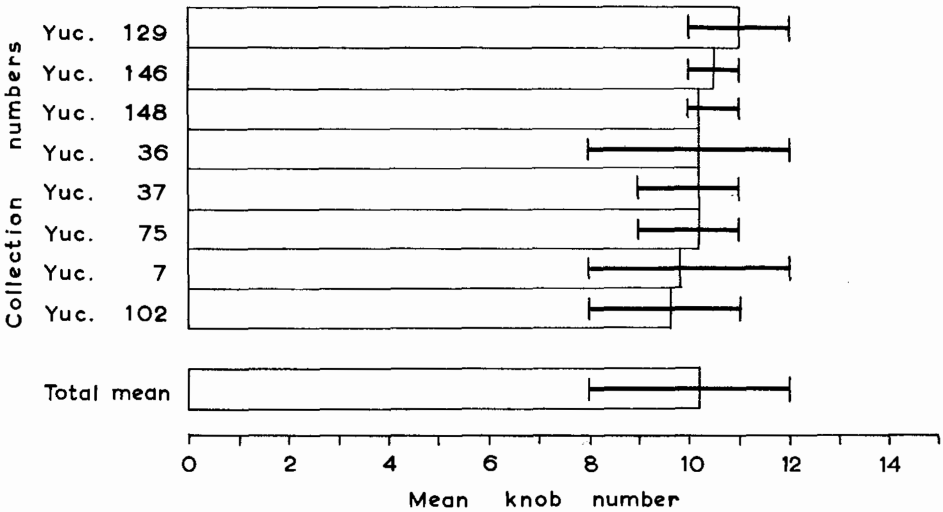


Figure 8a. Diagram showing mean knob number and the knob number variation (mid-line) for corn collections of the Nal-tel race from Guatemala.

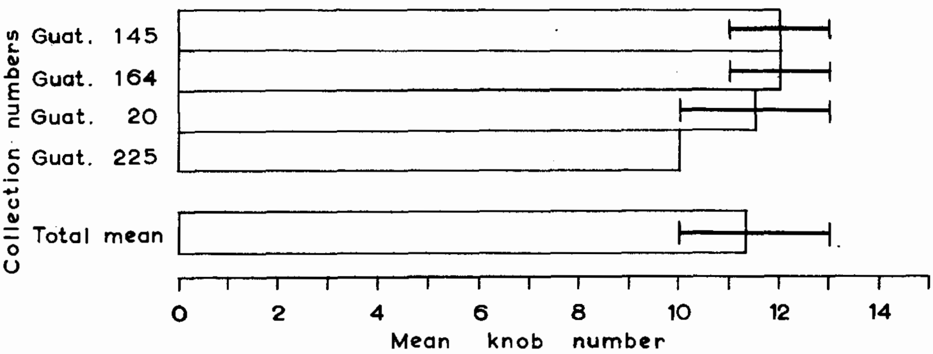


Figure 9a. Diagram showing mean knob number and the knob number variation (mid-line) for corn collections of the Nal-tel race from El Salvador.

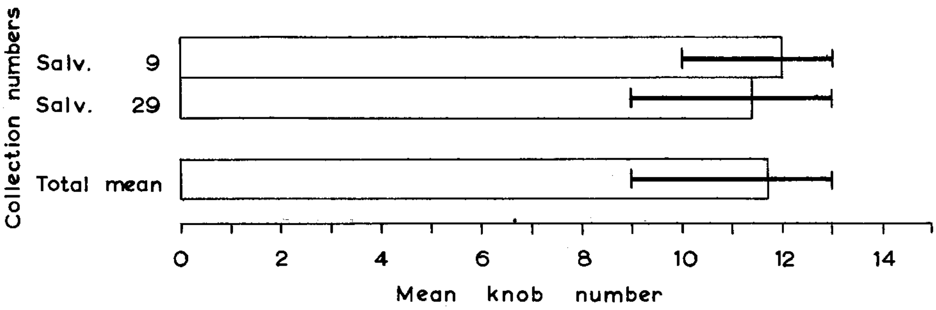


Figure 10a. Diagram showing mean knob number and the knob number variation (mid-line) for corn collections of the Venezuelan races Guaribero (Ven. 459, 530), Canilla (Ven. 513), Aragüito (Ven. 678) and Sabanero (Ven. 558).

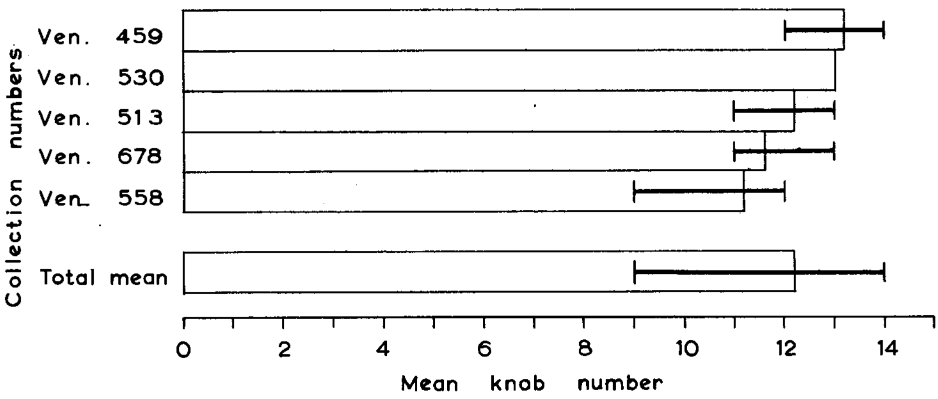


Figure 11a. Diagram showing mean knob number and the knob number variation (mid-line) for corn collections of the Pollo and Pira races.

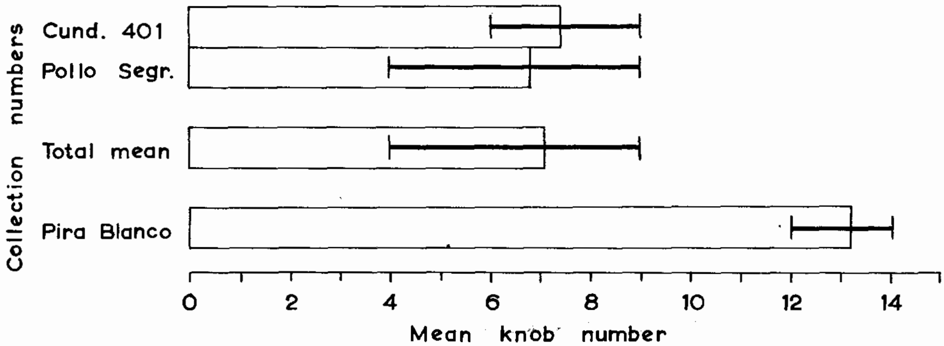


Figure 12a. Diagram showing mean knob number and the knob number variation (mid-line) for corn collections of the Enano (Bolivia 1143 and 1144) and Pororo (Bolivia 806) races.

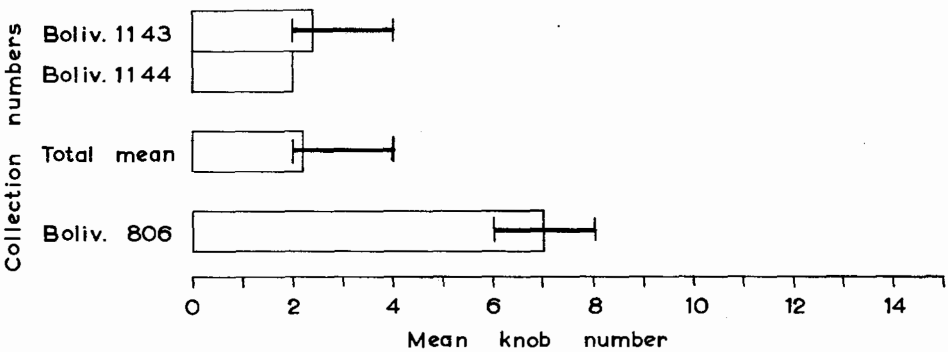


Figure 13a. Diagram showing mean knob number and the knob number variation (mid - line) for corn collections of the Canguil race.

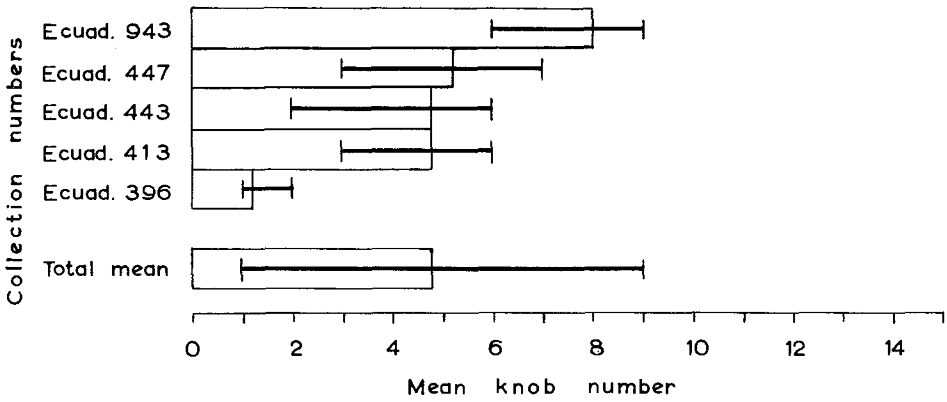


Figure 14a. Diagram showing mean knob number and the knob number variation (mid - line) for corn collections of the Confite Morocho race and the Confite Puntiagudo (Anc. 250) race.

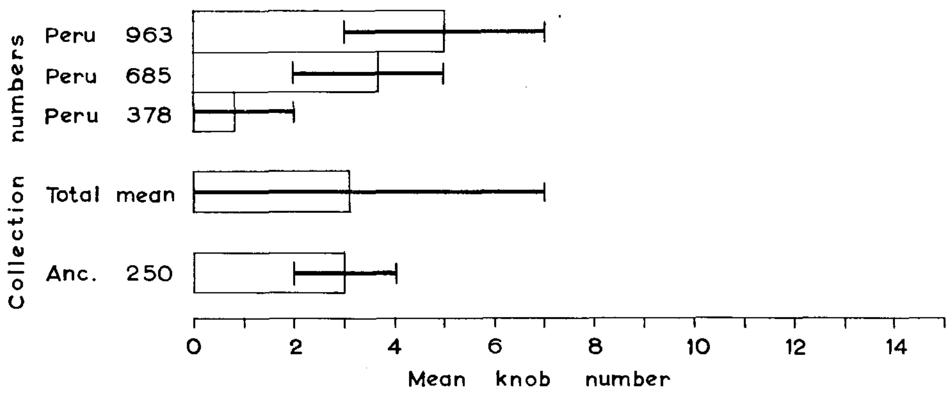


Figure 15a. Diagram showing mean knob number and the knob number variation (mid-line) for corn collections of the Pisinkalla race.

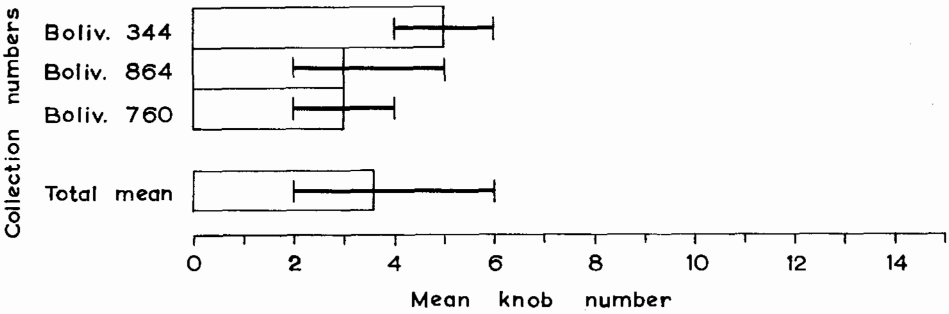
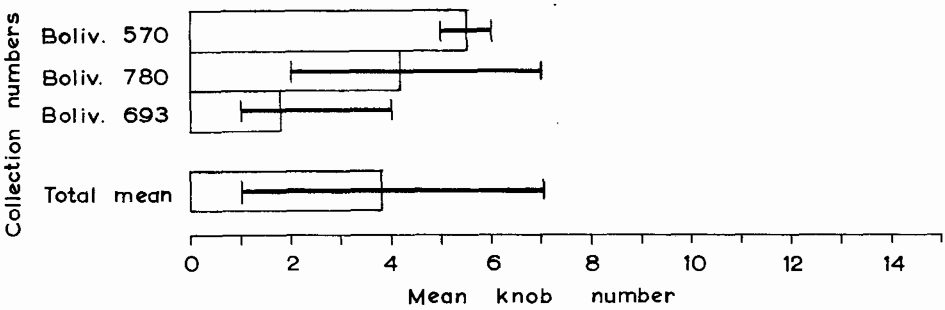


Figure 16a. Diagram showing mean knob number and the knob number variation (mid-line) for corn collections of the Pisinkalla - Pororo race.



SECTION B

THE CHROMOSOMES OF CENTRAL AMERICAN CORNS

Albert E. Longley and Takeo A. Kato Y.

The Central American countries have grown and used corn as a staple food for many many centuries. Their corns are well known and from the diverse types, corn breeders everywhere are seeking the untried germplasm for their corn improvement projects.

This cytological study includes over 275 corn collections from six Central American countries. The chromosome knobs of each collection and their morphological characteristics provide data useful in comparing differences in knob numbers and knob sizes. The collections are of representative corns from different environments ranging from sea level to mountain valleys 10,000 feet in elevation (Table 2b) and ranging from tropical to almost desert conditions.

The mean knob numbers found in corns from different areas of the six Latin American countries, are given in Table 1. More detailed analyses of the knobs of each collection are recorded in Tables 3b and 4b. It is evident that in all six countries the knob number for collections below the 4,000 ft. level is similar and that collections with the lower knob numbers come from the higher altitudes (Table 2b).

The data of Tables 1 and 2b-4b make it possible to study the knob complex of each collection and compare each chromosome complex with complexes of other collections of the same or different races and from the same or different environments.

The analyses of chromosome knob data will be simplified by treating first the large numbers of collections from Guatemala, first to evaluate several knob number relationships and later to compare these relationships with data from other collections of other countries or areas.

Figure 1b illustrates graphically the mean knob numbers that characterize the corn collections from different altitudes of Guatemala and Table 5b lists and Figure 2b illustrates the altitude and knob number characteristic of each of the 15 corn races found in our 175 or more corn collections. It is apparent that there is a relationship between the number of chromosome knobs and the morphological features of some corn races, and between the number of knobs and the elevation at which a collection was made. Both knob number and racial characteristics seem, therefore, to be associated with specific environments.

A separation into race groups of the data on chromosome knob number affords an opportunity to observe in detail the characteristic features of the different races. The Nal-Tel race deserves first attention, since it is a prevalent race in the mid-highlands of Guatemala and it has been long recognized as a primitive race.

The Nal-Tel race has been considered in the first section of this report. Additional cytological data from the past seasons study, however, seems to warrant a further treatment of this race.

The knob number of typical collections of Nal-Tel shown in Table 1, have been selected to provide data for Figure 3b. Figure 3b shows, in addition to the mean knob number of a collection, the observed variations in knob number among the plants representing this collection by a mid-line at the top of each column of the graph. This line shows the range of variation within the collection. The final column for each subdivision of the graph gives the mean knob number for the race and the total variation within the race.

The central section of Figure 3b is from the data of Nal-Tel collections that show suggestions of introgression from other races. It is evident that they have a slightly higher knob number than typical Nal-Tel collections. On the other hand, when Nal-Tel collections are isolated in such an area as Yucatán, Mexico, the knob numbers shown in the lowest section of Figure 3b, are lower than the Guatemalan Nal-Tel's of the top section.

The classifier found that in addition to the typical collections of a race, some collections belonged in an atypical group, while others belonged in a third introgression group. This separation is found in the three major columns of Table 5b.

The single atypical Nal-Tel collection (Table 5b) shows a slight increase in knob number from the mean number characteristic of typical collections. The several collections (Table 5b, right) showing detectable signs of introgressions from other races, are slightly different from true Nal-Tel in the altitude at which they grew and the number of chromosome knobs present. The contaminating races such as Tepecintle, possibly have contributed a slightly different chromosome knob complex, so that these off-type collections have an adaptability that makes them at home in a distinctly different environment.

The collector's and the cytological data indicate that this primitive race, Nal-Tel, is adapted in Guatemala to a mid-highland environment and that is has a high chromosome knob number.

The few collections of typical Nal-Tel Ocho shown in Table 1 are treated in a manner similar to the treatment of the typical Nal-Tel race. The collections of this race are too few to be of much value. Similarities and differences within race and within the two collections of the race can be recognized in

Figure 4b, top. The restricted number of collections and the variation in knob number make it difficult to assign specific cytological characteristics to this race. There is, however, a suggested relationship between collections from high altitudes and a low knob number and viceversa.

Another mid-highland race of Guatemala is Negro de Chimaltenango. The one representative of this race as it occurs in mid-highland areas has a high knob number as shown in Figure 5b. Other representatives of this race from higher altitudes will be considered later.

Collections of Dzit-Bacal frequently show signs of introgression. Fig. 6b for these off-type collections have only minor departures in chromosome knob complexes from typically mid-highland races. Although the collections came from noticeably lower altitudes, Comiteco, as represented by the few collections studied, is similar in chromosome knob number to Dzit-Bacal. The collections studied all have characters that suggest introgressions. The mean altitude given for these introgression types has placed them close to Nal-Tel and other mid-highland types. The knob data for this race are shown graphically in Figure 7b.

Tepecintle material was well represented in the collections studied. This race seems to have become adapted to a lower altitude than the races just considered. The several collections suggesting introgressions are from mid-highland areas and differ from the typical collections in having an increase in knob number similar to that found in the Nal-Tel introgressions. Typical Tepecintle data are used to illustrate the chromosome complex of this race (Figure 8b). Tepecintle is a race with a mid-highland knob number, but it shows a trend towards a lowland environment.

The trend towards a lowland environment is noticeable also in the few collections of Tuxpeño that were studied. Their knob numbers, however, are not significantly different from races next to them in the mid-highland area. The similarity will be apparent in Figure 9b, which pictures diagramatically knob numbers from both typical and off-type collections. Salvadoreño differs very little from Tuxpeño. The collections used for chromosome studies came from the lowlands. The knob numbers are similar to those prevalent in corns growing at mid-highland elevations, as are illustrated in Figure 10b.

Two collections of the Olotillo race concluded the study of material from areas below the 6,000 ft. level. This race has a knob number that is characteristic of corns found at mid-highland altitudes. The knob number and knob variations are shown diagramatically as part of Figure 4b.

The Flint-Dent Flour type, the Coastal Tropical Flints, and the Cuban Flints found in Guatemala, are included here in one group. They are a group that approach the lowlands in their adaptation. Excepting the Coastal Tropical and Cuban Flints, the group does not represent a race. All have knob number definitely lower than mid-highland races (Figure 11b). Similar materials are present in Caribbean collections, and these few collections will be almost duplicated when the Island flint-dent types are considered later in this presentation.

Negro de Chimaltenango of the highlands serves to bridge the gap between races of the highland environment and races characteristic of the mid-highland areas. Sister material has already been introduced and illustrated as a mid-highland (caliente) race. The four collections of the highland (frío) race are from altitudes 4,000 feet or more above the previously discussed Negro Caliente representative of this race. They are different also since they split the mid-highland chromosome knob number in half. Figure 5b and Tables 3b and 4b can be used to compare the differences in knob complexes of these two variations of this race.

The chromosome knob differences recognized in the above highland versus mid-highland corn comparison seems to place the responsibility for knob number differences more on changes in environment than on morphological features or race differences.

A truly highland group of collections is the Quicheño race. This race is found in the highland valleys where introgressions are much reduced, and racial characteristics become more clear cut. The knob number, the variations in size and position of knobs, typical for this race, are shown in Tables 3b and 4b and in Figure 12b. The few collections that suggest outside contamination have, what would seem to be, knob complexes that tie this highland corn to those from lower altitudes.

Olotón is also a characteristic highland race that has knob numbers in the collections that suggest introgressions and these serve to bridge the gap in chromosome knob complexes of typical highland and typical mid-highland corns. This, and other truly highland races, have knob numbers that are characteristically low. Figure 13b illustrates and Tables 3b and 4b give the knob pattern for this race with its low knob number.

Serrano and San Marceño represent true highland races of corn. Even the few collections of these races showing introgressions have little to indicate that they are contaminated by corn from lower altitudes. Figures 14b and 15b and Tables 3b and 4b serve to emphasize the characteristic knob pattern prevalent in corns from the high mountain valleys of Guatemala.

A summary of the data on the chromosome knobs of Guatemalan corns is as follows:

1.- Corns from areas below the 6,000 ft. elevation have high knob numbers.

2.- A slightly different knob number is found in collections that are typical of a race than in collections that suggest introgressions.

3.- The lowering of the knob number in a race more isolated than is possible where it grows near other races has been shown for typical collections of Nal-Tel from Yucatán, Mexico.

4.- Corn races from above the 6,000 ft. level have a high percent of collections showing no inter-race mixing.

5.- Typical highland races have low knob numbers.

6.- The knob number on the chromosomes of a plant or a race seem to be a record of the history of that plant or race. High knob numbers are associated with corns that have close neighbors and that have not moved from the mid-highland area. Low knob numbers belong to plants and races that come from isolated areas.

The corn collections from El Salvador, Honduras and Nicaragua are mostly characterized by introgressional tracts of races already considered in the preceding paragraphs (Table 1). The few collections of uncontaminated races are not appreciably different from their counterpart in Guatemala.

The collections from Costa Rica and Panama represent a change in the racial patterns seen in countries to the North. There are a few atypical collections of races already considered, but the majority represent races less prevalent in the Northern Central American countries.

Tables 1, 3b and 4b give the chromosome knob data for the collections from these two countries. Several of the races are represented by several collections and their mean chromosome knob number and the variation in number around this mean are shown graphically in Figures 16b to 22b.

Some of these races are represented in the corn collections from the Caribbean Islands and will receive further consideration in the next section of this presentation.

Table 6b and Figure 23b have been prepared to summarize the chromosome knob number characteristic for Latin American countries from Mexico to Panama.

The Mexican data used in this Table is from non-random collections. The 9.23 (unpublished) mean chromosome knob number comes from 14 collections (110 plants) made thirty years ago by collectors interested in exceptional corn types. The 9.55 number is from collections used in section "A" of this presentation.

The highest mean chromosome knob number in the seven Latin American countries is found in collections from Honduras and there is a small decrease in number in material coming from both North and South of this centrally-located country.

Table 2-b. Number of collections and mean chromosome knob size of Central American corns from different altitudes.

Altitude (ft.)	Guatemala		El Salvador		Honduras		Nicaragua		Costa Rica		Panama	
	No. of coll.	Mean knob No.	No. of coll.	Mean knob No.	No. of coll.	Mean knob No.	No. of coll.	Mean knob No.	No. of coll.	Mean knob No.	No. of coll.	Mean knob No.
10,000 - 9,000	5*	4.5										
8,999 - 8,000	13*	4.5										
7,999 - 7,000	23	5.9										
6,999 - 6,000	12	8.7			1	10.6			1	8.3		
5,999 - 5,000	4	9.3			3	12.8			1	6.0		
4,999 - 4,000	15*	11.3			2	11.3			7	9.3	3	8.2
3,999 - 3,000	32	12.2			3	12.5	1	11.2	4	11.5	3	10.2
2,999 - 2,000	19	11.9	1	11.4	6	13.9	2	13.0	2	11.0	2	9.9
1,999 - 1,000	21	12.6	4	11.9	2	13.3	6	12.8	4	12.2	3	12.9
999 - 0	26	11.7	4	12.1	3	12.3	2	12.0	16	12.6	11	11.1

*One progeny omitted.

Table 3b.- Data showing, for the various maize collections from Guatemala and the other Central American countries, the number of chromosome knobs at the 20 knob forming positions. Collections from each country are arranged in a descending order for the number of knobs present.

Collection No. and Country	Mean Knob No.	No. of Plants	Number of knobs at the 20 knob forming positions 1S a	1S b	1L	2S	2L	3S	3L	4S	4L	5L	6S	6L a	6L b	6L c	7S	7L	8L a	8L b	9S	9L	10L	Plants with ab 10	Total No. ab 10	Plants with BT	Total No. BType
Guatemala																											
326	15.5	2	2	-	1	2	2	1	2	1	2	2	X	-	2	2	1	2	2	2	2	1	1	-	-	-	-
111	14.7	4	4	-	-	4	4	4	4	-	4	4	X	-	4	4	4	4	4	4	4	2	1	-	-	-	-
79	14.0	2	2	-	-	2	2	-	2	-	2	2	X	-	2	2	2	2	2	2	2	2	-	-	-	1	2
106	14.0	2	-	-	-	2	2	2	2	-	2	2	X	-	2	1	1	2	2	2	1	2	1	1	1	-	-
226	14.0	2	2	-	-	1	2	1	2	-	2	2	X	1	2	2	2	2	2	2	2	1	-	1	1	-	-
333	14.0	2	2	-	2	1	2	-	2	-	2	2	X	-	2	2	1	2	2	2	2	2	-	-	-	-	-
769	14.0	2	2	-	-	2	2	2	2	-	2	2	X	-	2	2	1	2	2	1	2	2	-	-	-	-	-
72	13.5	2	2	-	-	2	2	-	2	-	2	2	X	-	2	2	1	2	2	2	2	2	-	-	-	-	-
88	13.5	2	2	2	-	1	2	-	2	-	2	2	X	-	2	2	-	2	2	2	2	2	-	-	-	-	-
90	13.5	2	2	-	-	2	2	-	2	-	2	2	1La	-	2	2	2	2	2	2	2	1	-	1	1	-	-
107	13.5	2	2	-	-	2	1	-	2	-	2	2	X	-	2	2	2	2	2	2	2	1	-	-	-	-	-
123	13.5	2	2	-	-	2	2	-	2	-	2	2	X	-	2	2	1	2	2	2	2	2	-	1	1	-	-
210	13.5	2	2	-	-	-	2	2	2	-	2	2	X	-	2	2	1	2	2	2	2	2	-	-	-	-	-
296	13.5	2	2	-	-	2	2	-	2	-	2	2	X	-	2	2	-	2	2	2	2	2	-	-	-	1	2
322	13.5	2	2	-	-	2	2	1	2	-	2	2	X	-	2	2	-	2	2	2	2	1	1	-	-	1	1
359	13.5	2	2	-	-	2	2	-	2	-	2	2	X	-	1	2	2	2	2	2	2	2	-	-	-	-	-
581	13.5	2	2	-	-	1	2	1	2	-	2	2	X	1	2	2	-	2	2	2	2	2	-	-	-	1	1
738	13.5	2	2	-	-	1	2	-	2	-	2	2	X	-	2	2	2	2	2	2	2	2	-	-	-	-	-
778	13.5	2	2	-	-	2	2	-	2	-	2	2	X	-	2	2	1	2	2	2	2	2	-	1	1	-	-
875	13.3	6	4	-	-	5	5	2	6	-	6	6	X	-	6	6	3	6	6	6	6	5	1	-	-	-	-
69	13.0	3	3	-	-	1	3	2	3	-	3	3	X	-	3	3	1	3	2	3	3	3	-	-	-	-	-
71	13.0	2	2	-	-	2	-	-	2	-	2	2	X	-	2	2	2	2	2	2	2	2	-	-	-	1	1
77	13.0	2	2	-	-	1	2	-	2	-	2	2	X	-	2	2	2	2	1	2	2	2	-	-	-	-	-
100	13.0	2	2	-	-	2	2	-	2	-	2	2	X	-	2	2	-	2	2	2	2	2	-	-	-	-	-
110	13.0	5	5	-	-	4	5	2	5	-	5	5	X	-	5	5	2	5	5	5	4	2	-	-	-	-	-
114	13.0	5	5	-	-	1	5	1	5	1	5	5	X	-	4	5	3	5	5	5	5	5	-	-	-	-	-
129	13.0	2	2	-	-	1	2	1	2	-	2	2	X	-	2	2	-	2	2	2	2	2	1	-	-	-	-
151	13.0	2	2	-	-	2	2	-	2	-	2	2	X	-	2	2	1	2	2	2	2	1	-	-	-	-	-
178	13.0	4	4	-	-	-	4	1	4	-	4	4	1La	-	4	4	3	4	4	4	4	3	-	1	1	-	-
179	13.0	2	2	-	-	-	2	-	2	-	2	2	X	-	2	1	2	2	2	2	2	2	1	-	-	-	-
239	13.0	2	2	-	1	2	2	-	2	-	2	2	X	-	2	1	-	2	2	2	2	2	-	1	1	-	-
259	13.0	4	4	-	-	3	4	-	4	-	4	4	X	-	4	4	1	4	4	4	4	3	1	1	1	-	-
262	13.0	2	2	-	-	-	2	1	2	-	2	2	X	-	2	2	2	2	2	2	2	1	-	-	-	-	-
313	13.0	2	2	-	-	-	2	1	2	-	2	2	X	-	2	1	2	2	2	2	2	2	-	-	-	-	-
594	13.0	2	2	-	1	2	2	-	2	-	1	2	X	-	2	2	1	2	2	1	2	2	-	2	2	-	-
597	13.0	2	2	-	-	2	2	-	2	-	2	2	X	-	2	2	1	2	2	2	2	1	-	-	-	-	-
600	13.0	2	1	-	-	2	2	-	2	-	2	2	X	-	2	2	2	2	2	1	2	2	-	2	2	-	-
649	13.0	2	2	-	-	2	2	-	2	-	2	2	X	-	2	2	-	2	2	2	2	2	-	1	1	-	-
710	13.0	5	5	-	-	2	4	3	5	-	5	5	X	-	4	5	3	5	5	5	5	3	1	-	-	-	-
68	12.8	5	5	-	4	-	5	-	5	-	5	5	X	-	4	5	3	5	5	5	5	3	-	-	-	5	12
220	12.8	5	5	-	-	2	4	2	5	-	5	5	X	-	5	5	3	5	5	5	4	3	1	-	-	-	-
349	12.8	7	6	-	-	6	4	3	7	-	7	7	X	-	6	6	5	7	7	6	7	5	-	1	1	-	-
331	12.6	5	5	-	1	3	4	-	5	-	5	5	X	-	5	5	2	5	5	5	5	3	-	3	3	-	-

Collection No. and Country	Mean Knob No.	No. of Plants	Number of knobs at the 20 knob forming positions 1S a	1S b	1L	2S	2L	3S	3L	4S	4L	5L	6S	6L a	6L b	6L c	7S	7L	8L a	8L b	9S	9L	10L	Plants with ab 10	Total No. ab 10	Plants with BT	Total No. B-Type
Guatemala																											
85	12.5	7	7	-	-	-	7	-	7	-	7	7	X	-	7	7	4	7	7	6	7	7	-	-	-	1	1
105	12.5	2	2	-	-	1	2	-	2	-	2	2	X	-	2	1	1	2	2	2	2	2	-	-	-	-	-
109	12.5	2	2	-	-	1	2	1	2	-	2	2	X	-	2	2	-	2	2	2	2	1	-	1	1	-	-
134	12.5	2	2	-	-	2	1	-	2	-	2	2	X	-	2	2	1	2	2	2	2	1	-	-	-	-	-
279	12.5	2	2	-	-	2	1	-	1	-	2	2	X	-	2	2	2	2	2	2	2	1	-	-	-	1	2
280	12.5	4	4	-	-	1	4	3	4	-	4	4	X	-	4	2	1	4	4	3	4	4	-	-	-	-	-
298	12.5	2	2	-	-	-	2	-	2	-	2	2	X	-	2	2	-	2	2	2	2	-	2	-	-	-	-
330	12.5	2	-	-	-	-	2	-	2	-	2	2	X	-	2	2	1	2	2	2	2	2	-	1	1	1	3
820	12.4	5	4	-	-	3	5	-	5	-	5	5	X	-	5	5	1	5	5	5	5	4	-	-	-	-	-
269	12.1	7	7	-	-	3	7	1	7	1	7	7	X	-	7	7	-	7	7	7	7	-	2	3	3	1	1
52	12.0	4	4	-	-	-	4	1	4	-	4	4	X	-	4	3	2	4	3	4	4	1	3	-	-	-	-
60	12.0	2	2	-	-	2	1	-	1	-	2	2	X	-	2	2	1	2	2	2	1	2	-	-	-	-	-
92	12.0	2	2	-	-	-	2	-	2	-	2	2	X	-	2	1	1	2	2	2	2	2	-	-	-	-	-
103	12.0	2	2	-	-	1	1	1	2	-	2	2	X	-	2	2	-	2	2	2	2	1	-	-	-	1	2
108	12.0	2	2	-	-	1	2	-	2	-	2	2	1La	-	2	2	-	2	2	2	2	1	-	1	1	-	-
116	12.0	2	2	-	-	2	2	1	2	-	2	2	X	-	2	1	-	2	2	2	2	-	-	-	-	-	-
135	12.0	2	2	-	-	1	2	1	2	-	2	2	X	-	2	2	-	2	2	2	2	-	-	-	-	-	-
145	12.0	5	5	-	-	-	5	-	5	-	5	5	X	-	5	5	2	5	5	5	5	2	-	1	1	-	-
148	12.0	2	1	-	-	1	2	-	2	-	2	2	X	-	2	2	2	2	2	2	2	-	-	-	-	-	-
155	12.0	2	2	-	-	-	2	-	2	-	2	2	X	-	2	2	-	2	2	2	2	2	-	-	-	-	-
158	12.0	5	5	-	-	1	5	-	5	-	5	5	X	-	5	5	-	5	5	5	5	4	-	2	3	-	-
160	12.0	2	2	-	-	1	2	-	2	-	2	2	X	1	1	1	1	2	2	1	2	2	-	2	4	-	-
164	12.0	2	2	-	-	1	2	-	2	-	2	2	X	-	2	2	-	2	2	-	2	2	1	1	1	-	-
229	12.0	2	2	-	-	-	2	-	2	-	2	2	X	-	2	2	1	2	2	2	2	1	1	-	-	-	-
253	12.0	2	2	-	-	-	2	-	2	-	2	2	X	-	2	2	1	2	2	2	1	2	-	-	-	1	1
260	12.0	2	2	-	-	-	2	-	2	-	2	2	X	-	2	2	1	2	2	2	2	1	-	-	-	-	-
314	12.0	2	2	-	-	1	2	-	2	-	2	2	X	-	2	2	2	2	2	2	-	1	-	-	-	-	-
316	12.0	2	1	-	-	1	2	-	2	-	2	2	X	-	2	2	1	2	2	2	2	1	-	-	-	-	-
426	12.0	2	2	-	-	1	2	1	2	-	2	2	X	-	2	-	-	2	2	2	2	2	-	-	-	1	2
744	12.0	3	3	-	-	1	3	-	3	-	3	3	X	-	2	3	1	3	3	2	3	2	-	-	-	-	-
793	12.0	2	2	-	-	1	2	-	2	-	2	2	X	-	2	2	1	2	2	2	2	-	-	-	-	-	-
120	11.8	4	4	-	-	3	4	-	4	-	4	4	X	-	4	3	1	2	2	3	3	-	-	-	-	1	1
765	11.8	8	6	-	-	4	8	-	8	-	8	8	X	-	8	6	1	8	8	8	8	6	-	-	-	-	-
133	11.6	3	3	-	-	2	3	-	3	-	3	3	1La	-	3	2	-	3	3	3	3	-	-	-	-	-	-
207	11.6	5	5	-	-	1	5	1	5	-	5	5	X	-	4	5	1	5	5	5	5	1	-	2	2	-	-
329	11.6	9	7	-	-	5	9	-	9	-	9	9	X	-	9	9	3	9	9	9	9	1	-	-	-	-	-
4	11.5	2	2	-	-	1	2	1	2	-	2	2	X	-	1	2	-	2	2	2	2	-	-	-	-	-	-
20	11.5	2	2	-	1	2	2	-	2	-	2	2	X	-	1	2	-	2	2	-	1	2	-	-	-	-	-
81	11.5	2	2	-	-	-	2	-	2	-	2	2	X	-	2	1	1	2	2	1	2	2	-	-	-	-	-
143	11.5	2	2	-	-	1	2	-	2	-	2	2	X	-	2	2	-	2	2	2	2	-	-	-	-	-	-
174	11.5	2	2	-	-	-	2	-	2	-	2	2	X	-	2	2	1	2	2	2	2	-	-	-	-	-	-
321	11.5	2	2	-	-	-	2	1	2	-	2	2	X	-	2	2	-	2	2	2	2	-	-	-	-	-	-
338	11.5	2	2	-	-	1	2	-	1	-	2	2	X	-	2	2	-	2	2	2	2	-	1	-	-	-	-
351	11.5	2	2	-	-	1	2	-	2	-	2	2	X	-	2	2	-	2	2	2	1	1	-	-	-	-	-
529	11.5	2	2	-	-	1	2	-	2	-	2	2	X	-	2	2	-	2	2	-	2	2	-	-	-	-	-
573	11.5	7	7	-	-	1	7	1	3	-	7	7	X	-	7	7	4	7	6	6	7	4	-	-	-	-	-
760	11.5	2	2	-	-	-	2	-	2	-	2	2	X	-	2	2	2	2	2	1	2	-	-	-	-	-	-
821	11.5	2	2	-	-	1	2	-	2	-	2	2	X	-	2	2	-	2	1	2	2	1	-	-	-	-	-
937	11.5	2	2	-	-	1	2	-	2	-	2	2	1La	-	1	1	-	2	2	2	2	2	-	1	1	-	-
281	11.2	5	3	-	-	-	5	-	5	-	5	5	X	1	5	5	2	5	4	5	4	2	-	1	1	1	2

ollection No. nd Country	Mean Knob No.	No. of Plants	Number of knobs at the 20 knob forming position 1S a	1S b	1L	2S	2L	3S	3L	4S	4L	5L	6S	6L a	6L b	6L c	7S	7L	8L a	8L b	9S	9L	10L	Plants with ab 10	Total No. ab 10	Plants with BT	Total No. B-Type
Guatemala																											
161	11.1	7	6	-	-	5	7	1	6	-	7	7	X	2	6	3	-	7	5	5	7	2	2	3	3	-	-
87	11.0	2	2	-	-	-	2	-	2	-	2	2	X	-	2	2	1	2	2	1	2	-	-	-	-	1	1
115	11.0	2	2	-	-	1	2	-	2	-	2	2	X	-	2	1	-	2	2	2	2	-	-	-	-	-	-
231	11.0	2	2	-	-	-	2	-	2	-	2	2	X	-	1	2	1	2	2	1	2	1	-	-	-	-	-
242	11.0	2	2	-	-	-	2	-	-	-	2	2	X	-	2	2	2	2	2	2	2	-	-	-	-	-	-
344	11.0	4	3	-	-	1	4	-	4	2	4	4	X	-	4	-	1	4	4	4	4	1	-	1	1	2	3
552	11.0	3	3	-	-	1	3	-	3	-	3	2	X	-	3	2	-	3	3	2	3	2	-	-	-	2	2
809	11.0	2	2	-	-	-	2	-	2	-	2	2	X	-	2	1	-	2	2	2	2	1	-	-	-	-	-
131	11.0	5	3	-	-	-	5	-	5	-	5	5	X	-	5	4	1	5	-	5	5	5	2	-	-	-	-
130	10.6	5	4	-	-	2	5	-	5	-	5	5	X	-	3	4	-	5	5	4	5	1	-	1	2	-	-
603	10.5	2	-	-	-	2	1	-	2	-	2	2	X	-	2	2	-	2	2	2	2	-	-	-	-	-	-
74	10.0	2	2	-	-	-	-	-	2	-	2	2	X	-	2	2	-	2	2	1	2	1	-	-	-	-	-
225	10.0	2	2	-	-	-	2	-	2	-	2	2	X	-	2	2	-	2	2	2	-	-	-	-	-	-	-
459	10.0	2	2	-	-	1	1	-	2	-	2	2	X	-	2	2	-	2	2	1	1	-	-	-	-	-	-
473	10.0	2	2	-	-	-	2	-	2	-	2	2	X	-	2	2	-	2	2	2	-	-	-	-	-	-	-
544	10.0	2	2	-	-	-	2	-	1	-	2	2	1La	-	2	2	-	2	2	2	1	-	-	-	-	-	-
591	10.0	2	-	-	-	2	1	-	2	-	-	2	1La	-	2	1	-	2	2	2	2	1	-	-	-	-	-
642	10.0	2	2	-	-	2	2	-	1	-	-	2	X	1	2	2	-	2	2	-	1	1	-	-	-	-	-
806	10.0	2	2	-	-	-	2	-	2	-	2	2	1La	-	2	-	-	2	2	2	2	-	-	1	1	-	-
448	9.8	5	5	-	-	1	3	-	4	-	4	5	2La	-	5	5	-	5	4	5	3	-	-	-	-	-	-
651	9.6	3	1	-	-	-	3	-	3	-	3	3	X	-	3	2	-	3	2	1	3	1	1	-	-	-	-
320	9.5	2	2	-	-	-	2	-	-	-	2	2	X	-	2	2	1	2	2	2	-	1	-	-	-	-	-
539	9.5	2	2	-	-	1	2	-	1	-	2	2	X	-	2	1	-	2	2	-	2	-	-	-	-	-	-
635	9.3	3	3	-	-	3	-	-	-	-	3	3	X	-	3	3	-	3	3	-	3	1	-	-	-	-	-
209	9.0	4	3	-	-	-	4	-	1	-	4	4	X	-	4	3	-	4	4	-	4	1	-	1	1	-	-
257	9.0	3	-	-	2	1	-	-	-	-	3	3	X	-	3	3	1	3	2	1	3	2	-	-	-	-	-
508	9.0	2	2	-	-	1	2	-	2	-	1	2	X	-	-	1	-	2	2	2	1	-	-	-	-	-	-
746	9.0	2	-	-	-	-	2	-	2	-	2	2	X	-	-	2	-	2	2	-	2	2	-	-	-	-	-
841	9.0	2	-	-	-	1	1	-	-	-	2	2	1La	-	2	2	-	2	2	1	1	1	-	-	-	-	-
27	8.6	3	1	-	-	2	2	-	1	-	3	3	X	-	2	1	1	3	2	3	2	-	-	-	-	-	-
187	8.5	2	1	-	-	2	2	-	-	-	1	2	X	-	1	2	1	2	2	-	1	-	-	-	-	-	-
477	8.5	2	1	-	-	-	2	-	2	-	2	2	X	-	2	1	-	2	1	-	1	1	-	-	-	-	-
576	8.5	2	2	-	-	-	1	-	2	-	2	2	X	-	2	1	-	2	1	1	1	-	-	-	-	-	-
577	8.5	2	1	-	-	-	2	-	2	-	2	2	X	-	1	-	-	2	2	-	2	-	1	-	-	-	-
393	8.0	2	2	-	-	-	-	-	2	-	1	2	X	-	-	2	-	2	2	1	2	-	-	1	1	-	-
637	8.0	2	1	-	-	-	-	-	2	-	2	2	X	-	1	1	-	2	2	-	2	1	-	-	-	-	-
678	8.0	1	1	-	-	-	-	-	-	-	1	1	X	-	1	1	-	1	1	1	-	-	-	-	-	-	-
704	8.0	2	-	-	-	-	2	-	-	-	2	2	X	-	2	-	-	2	2	2	-	2	-	-	-	-	-
944	8.0	2	-	-	-	1	2	-	2	-	2	2	X	-	-	1	-	2	2	-	2	-	-	1	1	-	-
455	7.5	2	1	-	-	1	2	-	1	-	-	2	X	-	1	2	-	2	2	-	1	-	-	-	-	-	-
705	7.5	2	-	-	-	1	2	-	1	-	-	2	X	-	2	-	-	2	2	1	2	-	-	1	2	-	-
31	7.0	2	2	-	-	-	-	-	2	-	2	2	X	-	-	-	-	2	2	-	1	1	-	-	-	-	-
480	7.0	2	1	-	-	1	2	-	2	-	-	2	X	-	-	-	-	2	2	-	2	-	-	-	-	-	-
590	7.0	2	1	-	-	1	-	-	-	-	2	2	X	1	1	1	-	2	2	-	1	-	-	-	-	-	-
908	6.7	3	3	-	-	-	1	-	1	-	-	3	X	-	1	-	-	3	1	2	2	-	3	-	-	-	-
583	6.5	2	-	-	-	1	2	-	-	-	1	2	X	-	2	1	-	2	1	-	1	-	-	-	-	-	-
382	6.0	2	2	-	-	-	-	-	2	-	1	2	X	-	-	-	-	2	2	-	1	-	-	-	-	-	-
497	6.0	2	-	-	-	1	2	-	-	-	-	2	X	-	-	-	1	2	-	2	2	-	-	-	-	-	-
924	6.0	2	2	-	-	-	-	-	2	-	1	2	X	-	-	-	-	2	2	1	-	-	-	-	-	-	-
742	5.6	3	1	-	-	2	-	-	2	-	-	3	X	-	-	-	-	3	1	2	1	-	2	-	-	-	-
647	5.6	5	-	-	1	-	1	-	1	-	-	5	X	-	2	4	-	5	2	1	5	1	-	1	1	-	-
835	5.6	5	1	-	-	-	3	-	-	-	4	5	X	-	2	3	-	5	1	1	-	2ab	3	-	-	-	-

Collection No. and Country	Mean Knob No.	No. of Plants	1S a	1S b	1L	2S	2L	3S	3L	4S	4L	5L	6S	6L a	6L b	6L c	7S	7L	8L a	8L b	9S	9L	10L	Plants with ab 10	Total No. ab 10	Plants with BT	Total No. BT
			Number of knobs at the 20 knob forming positions																								
Guatemala																											
465	5.5	2	1	-	-	-	1	-	2	-	-	2	X	-	-	-	-	2	-	1	1	-	1	-	-	-	-
596	5.5	2	-	-	-	-	-	-	2	-	-	2	X	-	-	-	-	2	2	1	2	-	-	-	-	-	-
8	5.0	1	-	-	-	-	-	-	-	-	1	1	X	-	-	-	-	1	1	1	-	-	-	-	-	-	-
431	5.0	2	-	-	-	-	-	-	2	-	-	2	X	-	-	-	-	2	2	1	1	-	-	-	-	-	-
522	5.0	2	-	-	-	1	-	-	2	-	1	2	X	-	-	2	-	2	-	-	-	-	-	-	-	-	-
607	5.0	2	-	-	-	-	-	-	-	-	-	2	X	-	2	-	-	2	2	-	2	-	-	-	-	-	-
619	5.0	2	-	-	-	2	2	-	1	-	1	2	X	-	-	-	-	2	-	-	-	-	-	-	-	-	-
22	4.6	5	2	-	-	2	1	-	-	-	3	5	X	-	-	-	-	5	3	2	-	-	-	-	-	-	-
461	4.5	2	1	-	-	-	-	-	1	-	1	2	X	-	-	-	-	2	1	-	1	-	-	-	-	-	-
674	4.5	2	-	-	-	-	-	-	-	-	-	2	X	-	-	2	-	2	1	2	-	-	-	-	-	-	-
909	4.5	2	-	-	-	-	1	-	2	-	-	2	X	-	-	-	-	2	-	1	1	-	-	-	-	-	-
934	4.5	2	2	-	-	-	1	-	-	-	-	2	X	-	-	-	-	2	2	-	-	-	-	-	-	-	-
852	4.4	5	2	-	-	-	2	-	2	-	2	3	X	-	-	2	-	5	2	1	-	-	1	-	-	-	-
458	4.1	7	-	-	-	1	1	-	1	-	-	3	3La	-	4	-	-	7	3	2	6	-	1	-	-	-	-
386	4.0	2	-	-	-	-	1	-	2	-	-	2	X	-	-	-	-	2	-	1	1	-	-	-	-	-	-
413	4.0	2	1	-	-	-	-	-	1	-	-	2	X	-	-	-	-	2	-	1	1	-	-	-	-	-	-
513	4.0	2	-	-	-	-	-	-	1	-	-	2	X	-	-	1	-	2	-	1	1	-	-	-	-	-	-
895	4.0	2	-	-	-	-	1	-	-	-	1	1	X	-	-	-	-	2	-	-	2	-	1	-	-	-	-
492	3.5	2	-	-	-	-	1	-	1	-	-	1	X	-	1	-	-	2	-	1	-	-	-	-	-	-	-
902	3.5	2	2	-	-	-	-	-	-	-	1	2	X	-	-	-	-	2	-	-	-	-	-	-	-	-	-
491	3.3	3	-	-	-	1	1	-	-	-	-	2	X	-	1	-	-	3	-	1	2	-	-	-	-	-	-
37	3.0	2	2	-	-	-	-	-	-	-	-	2	X	-	-	-	-	2	-	-	-	-	-	-	-	-	-
427	3.0	2	-	-	-	-	-	-	-	-	-	2	X	-	-	-	-	2	2	-	-	-	-	-	-	-	-
564	3.0	2	-	-	-	-	-	-	1	-	-	2	X	-	-	-	-	2	-	-	1	-	-	-	-	-	-
423	2.5	2	1	-	-	-	-	-	-	-	1	-	X	-	1	-	-	2	-	-	-	-	-	-	-	-	-
14	2.0	2	-	-	-	-	1	-	-	-	-	2	X	-	-	-	1	-	-	-	-	-	-	-	-	-	-
El Salvador																											
71J	13.2	5	5	-	4	3	5	4	5	-	5	5	X	-	5	4	-	5	5	4	5	3	-	3	3	3	5
13J	13.0	5	4	-	-	2	5	2	5	-	5	5	X	-	5	5	2	5	5	5	5	4	1	-	-	1	1
30J	12.6	5	5	-	-	4	5	2	4	-	5	5	X	1	5	4	1	5	5	5	5	2	-	-	-	4	11
9	12.0	5	4	-	2	4	5	-	5	-	5	5	X	-	4	5	-	4	5	5	5	2	-	2	2	1	1
65J	11.6	5	4	-	1	-	5	1	5	-	5	5	X	-	5	5	1	5	5	5	5	1	-	-	-	1	2
59J	11.6	5	5	-	-	1	4	-	4	-	5	5	X	-	5	4	2	5	5	5	5	2	1	-	-	-	-
6J	11.4	5	3	-	-	4	3	2	4	-	5	5	X	-	5	5	-	5	5	5	5	1	-	-	-	-	-
29	11.4	5	3	-	1	4	3	2	5	-	5	5	X	-	5	3	-	5	5	5	5	1	-	-	-	2	3
54J	10.8	5	5	-	-	1	4	I	5	-	5	5	X	-	4	4	1	5	5	5	5	-	-	1	1	-	-
Honduras																											
76J	14.4	5	4	-	2	5	5	4	5	-	5	5	X	-	5	5	3	5	5	5	5	4	-	1	1	-	-
78J	14.2	5	5	-	1	4	5	4	5	2	5	5	X	-	5	5	1	5	5	5	4	4	1	2	2	2	5
66J	14.0	5	5	-	1	4	5	3	5	1	5	5	X	-	5	5	4	5	5	5	5	2	-	-	-	1	2
6J	14.0	5	5	-	3	5	5	3	5	1	5	5	X	-	5	4	2	5	5	5	5	2	-	-	-	-	-
15J	13.8	5	5	-	1	4	5	2	5	-	5	5	X	-	4	4	5	5	5	5	5	3	-	-	-	-	-
10J	13.8	5	5	-	1	5	5	2	5	1	5	5	X	-	5	5	-	5	5	5	5	5	-	-	-	-	-
55J	13.8	5	5	-	2	5	5	3	5	-	5	5	X	-	4	5	-	5	5	5	5	5	-	2	2	-	-
83J	13.6	5	5	-	-	3	5	4	5	2	5	5	X	-	5	4	1	5	5	5	5	4	-	-	-	1	2
50J	13.6	5	5	-	1	5	5	3	5	1	5	5	X	-	5	5	2	5	5	5	5	1	-	-	-	3	4
82J	13.0	5	5	-	-	4	5	2	5	-	5	5	X	-	5	5	-	5	5	5	5	4	-	-	-	3	5
62J	13.0	5	5	-	-	5	2	2	5	3	5	5	X	-	5	5	2	5	5	5	3	3	-	-	-	1	2
102J	13.0	5	5	-	-	5	4	2	5	-	5	5	X	-	5	5	1	5	5	5	5	3	-	2	2	-	-
7J	12.6	5	5	-	1	5	5	1	4	-	5	5	X	1	5	5	-	5	5	4	5	2	-	-	-	-	-

Collection No. and Country	Mean Knob No.	No. of Plants	Number of knobs at the 20 knob forming positions: 1S a	1S b	1L	2S	2L	3S	3L	4S	4L	5L	6S	6L a	6L b	6L c	7S	7L	8L a	8L b	9S	9L	10L	Plants with ab 10	Total No. ab 10	Plants with BT	Total No. BT
Honduras																											
14J	12.4	5	5	-	-	4	4	-	5	-	5	4	X	3	4	5	-	5	5	4	5	3	1	-	-	-	-
12J	12.2	5	5	-	-	3	5	-	5	-	5	5	X	-	5	5	-	5	5	4	5	4	-	-	-	-	-
21J	12.0	5	4	-	1	3	4	-	5	1	5	5	X	-	5	5	-	5	5	5	5	2	-	-	-	1	1
32J	12.0	5	5	-	-	3	5	-	4	-	5	5	X	2	5	4	1	5	5	5	5	1	-	1	1	1	2
41J	11.2	5	5	-	-	-	5	-	5	-	5	5	X	-	5	5	-	5	3	4	5	3	1	-	-	-	-
3J	10.6	5	4	-	-	4	4	-	4	-	4	5	X	-	2	5	-	5	5	5	5	1	-	-	-	-	-
20J	10.0	4	4	-	-	-	2	-	4	-	4	4	X	-	2	4	-	4	4	4	2	1	1	-	-	-	-
5J	9.6	5	4	-	-	-	5	-	5	-	5	5	X	-	4	3	-	5	5	1	5	2	-	-	-	-	-
Nicaragua																											
3445	14.0	5	5	2	1	3	5	3	5	-	5	5	X	-	5	5	2	5	5	5	5	4	-	1	1	-	-
3401	13.6	5	5	-	-	5	5	-	5	2	5	5	X	-	5	5	1	5	5	5	5	5	-	1	1	-	-
3429	13.4	5	5	-	-	4	5	-	5	2	5	5	X	-	5	5	2	5	5	5	5	4	-	1	1	-	-
3424	13.0	5	5	-	-	4	5	2	5	1	5	5	X	-	5	4	2	5	5	5	5	2	-	-	-	5	7
3380	12.6	5	5	-	-	2	4	2	5	-	5	5	X	-	5	5	1	5	5	5	5	4	-	-	-	-	-
3432	12.6	5	5	-	1	4	5	2	5	-	5	5	X	-	5	4	1	5	5	5	4	2	-	1	1	-	-
2	12.6	5	3	-	-	2	5	2	5	-	5	5	X	-	5	5	2	5	5	5	5	4	-	-	-	-	-
33	12.6	5	5	-	3	1	5	1	5	-	5	5	X	-	5	5	1	5	5	5	5	2	-	-	-	-	-
3449	12.2	5	5	-	1	3	5	2	5	-	5	5	X	-	5	4	-	5	5	4	5	2	-	-	-	-	-
3378	11.4	5	5	-	-	1	4	-	5	-	5	5	X	-	5	5	-	5	5	5	5	2	-	-	-	3	6
3406	11.2	5	5	-	-	4	4	-	3	-	5	5	X	-	5	5	-	5	5	5	5	1	-	-	-	-	-
3357	11.2	5	5	-	-	2	4	-	5	-	5	5	X	-	5	2	-	5	5	4	5	4	-	1	1	-	-
3411	10.4	5	4	-	-	2	5	2	5	-	5	4	X	-	2	4	-	5	5	3	4	2	-	-	-	-	-
Costa Rica																											
107	14.4	5	5	-	-	5	5	5	5	1	5	5	X	-	5	5	1	5	5	5	5	5	-	-	-	-	-
166	14.0	5	5	-	1	5	4	4	5	2	5	5	X	-	5	5	1	5	5	5	4	4	-	2	2	-	-
379	14.0	5	5	-	1	5	5	3	5	1	5	5	X	-	5	5	-	5	5	5	4	5	1	-	-	-	-
380	13.6	5	5	-	1	4	5	2	5	2	5	5	X	-	5	5	1	5	5	5	5	3	-	1	1	1	2
58	13.6	5	4	-	-	4	5	1	5	1	5	5	X	-	5	5	5	5	5	5	5	2	-	2	3	1	1
182	13.6	5	5	-	-	5	5	1	5	1	5	5	X	-	5	5	3	5	5	5	5	3	-	-	-	-	-
92	13.4	5	5	-	2	3	3	1	5	1	5	5	X	-	5	5	4	5	5	5	5	3	-	-	-	-	-
296	13.0	5	5	-	-	5	4	3	5	-	5	5	X	-	5	4	2	5	5	5	5	2	-	-	-	-	-
138	12.8	5	5	-	-	4	5	2	5	1	5	5	X	-	5	3	1	5	5	5	5	3	-	1	1	-	-
97	12.8	5	5	-	-	4	5	-	5	3	5	5	X	-	5	5	1	5	5	4	5	2	-	-	-	-	-
135	12.8	5	5	-	-	5	5	3	5	-	5	5	X	-	4	5	1	5	5	5	5	1	-	-	-	-	-
114	12.4	5	4	-	-	5	5	2	5	-	5	5	X	-	5	3	2	5	5	5	5	1	-	-	-	-	-
103	12.2	5	5	-	-	1	5	5	5	-	5	5	X	-	5	1	-	5	5	5	5	4	-	-	-	-	-
63	12.2	5	3	-	-	2	4	3	5	-	5	5	X	-	5	4	2	5	5	5	5	3	-	2	2	-	-
5	11.8	5	5	-	-	3	1	1	5	1	5	5	X	-	4	4	2	5	5	5	3	4	1	1	1	-	-
71	11.6	5	2	-	-	4	1	-	5	-	5	5	X	-	5	2	4	5	5	5	5	5	-	1	1	-	-
86	11.4	5	5	-	1	2	5	-	4	1	5	5	X	-	5	5	-	5	2	4	5	3	-	-	-	-	-
59A	11.2	5	5	-	-	-	4	-	5	-	5	5	X	-	5	4	1	5	5	5	5	2	-	-	-	-	-
22	11.2	5	4	-	-	4	4	1	5	-	5	5	X	-	4	2	2	5	5	4	4	2	-	-	-	-	-
59	11.2	5	2	-	-	2	5	-	5	-	5	5	X	-	5	4	1	5	5	5	4	3	-	-	-	-	-
280	11.2	5	4	-	-	3	5	1	5	-	5	4	X	-	5	5	-	5	5	5	2	2	-	-	-	-	-

Collection No. and Country	Mean Knob No.	No. of Plants	1S a	1S b	1L	2S	2L	3S	3L	4S	4L	5L	6S	6L a	6L b	6L c	7S	7L	8L a	8L b	9S	9L	10L	Plants with ab 10	Total No. ab 10	Plants with BT	Total No. BT
			Number of knobs at the 20 knob forming positions																								
Costa Rica																											
45	10.8	5	4	-	-	5	3	-	5	-	5	5	X	-	5	3	-	5	5	5	4	-	-	-	-	-	-
37	10.8	5	4	-	-	2	3	1	5	-	5	5	X	-	5	4	-	5	5	5	2	2	-	-	-	-	-
26	10.6	5	3	-	-	3	2	1	3	-	4	5	X	-	5	5	1	5	5	5	3	3	-	-	-	-	-
42	10.6	5	4	-	-	3	3	1	5	-	5	5	X	-	3	5	-	5	5	4	2	3	-	-	-	-	-
95	10.6	5	1	-	-	-	5	1	5	-	5	5	X	-	5	1	2	5	5	5	5	3	-	-	-	-	-
254	10.0	5	4	-	-	3	2	-	5	-	5	4	X	-	3	5	-	5	5	4	2	3	-	-	-	-	-
279	9.8	5	2	-	-	4	2	-	5	-	5	5	X	-	5	4	-	5	4	3	3	2	-	-	-	-	-
315	9.4	5	5	-	-	2	4	-	5	-	4	5	X	-	4	4	-	5	3	1	3	2	-	-	-	-	-
400	9.2	5	4	-	1	2	3	-	3	1	4	5	X	-	4	5	-	4	4	1	3	2	-	-	-	-	-
11	9.2	5	2	-	-	2	4	-	5	-	2	5	X	-	2	5	-	5	3	4	3	3	1	-	-	-	-
12	8.4	5	1	-	-	5	-	-	2	-	5	5	X	-	3	5	-	5	5	1	3	2	-	-	-	-	-
345	8.3	3	3	-	-	2	1	-	3	-	-	3	X	-	2	2	-	1	3	-	2	3	-	-	-	-	-
18	8.0	5	4	-	1	-	4	-	4	-	1	5	X	-	3	4	-	4	4	3	3	-	-	-	-	-	-
334	6.0	5	1	-	-	1	-	-	5	-	1	4	X	-	3	5	-	2	5	2	1	-	-	-	-	-	-
Panama																											
2B	14.2	5	5	-	-	5	3	4	5	-	5	5	X	-	5	5	4	5	5	5	5	5	-	-	-	-	-
5P	13.0	5	5	-	1	3	5	3	5	-	5	5	X	-	5	5	-	5	5	5	5	3	-	-	-	-	-
18B	12.6	5	5	-	-	-	5	4	5	-	5	5	X	-	4	5	1	5	4	5	5	4	1	1	1	-	-
12M	12.2	5	5	-	-	3	3	2	5	1	5	5	X	-	5	5	-	5	5	2	5	5	-	1	1	-	-
3Q	12.0	4	4	-	-	3	2	2	4	-	4	2	X	-	4	4	-	4	4	4	4	3	-	-	-	-	-
11M	12.0	5	5	-	-	4	4	4	5	-	5	5	2La	-	5	1	-	5	5	3	5	4	-	1	2	-	-
20M	11.8	5	5	-	-	5	4	3	5	-	5	5	X	-	5	2	1	5	5	-	5	4	-	-	-	-	-
39P	11.6	5	3	-	-	4	3	3	5	-	3	5	X	-	5	4	2	5	5	5	4	2	-	-	-	-	-
2C	11.4	5	2	-	-	-	5	-	5	1	5	5	X	-	4	4	4	5	5	5	5	2	-	1	2	-	-
31B	11.0	5	2	-	-	3	3	-	4	-	5	5	X	-	5	5	2	5	5	3	5	3	-	-	-	-	-
23P	10.8	5	3	1	1	-	5	-	4	-	5	5	X	-	4	5	-	5	5	4	5	2	-	-	-	-	-
35P	10.6	5	2	-	-	2	5	1	3	-	5	4	X	-	5	3	-	5	5	5	3	5	-	-	-	-	-
12P	10.2	5	3	-	2	2	5	-	3	-	5	5	X	-	5	3	-	5	3	3	4	3	-	3	3	-	-
28P	10.0	4	2	-	-	2	2	-	2	-	4	4	X	-	4	2	2	4	4	4	4	-	-	-	-	-	-
36B	10.0	5	4	-	-	-	5	-	5	-	4	5	X	-	5	3	-	5	5	4	5	-	-	-	-	-	-
13M	9.8	5	5	-	-	2	-	2	4	-	5	5	X	-	4	5	1	5	4	3	2	2	-	-	-	-	-
11P	9.6	5	2	-	-	-	3	2	5	-	5	5	X	-	3	5	-	5	4	5	3	1	-	-	-	-	-
18Q	9.6	5	4	-	-	2	3	-	5	-	5	5	X	-	5	3	-	5	4	4	2	1	-	-	-	-	-
7P	9.0	5	3	-	-	5	2	-	4	-	3	3	X	-	4	5	-	4	5	2	3	2	-	-	-	-	-
20P	8.8	5	-	-	-	2	-	-	3	-	5	5	X	-	5	5	-	5	5	5	3	1	-	-	-	-	-
15P	8.2	5	1	-	-	-	-	-	-	-	5	5	X	-	4	5	-	5	5	5	3	3	-	-	-	-	-
21P	7.2	10	-	-	-	7	1	-	2	-	10	9	X	-	8	8	-	10	2	5	9	1	-	-	-	-	-

Table 4b.- Data from the various maize collections from Guatemala and the other Central American countries, arranged in the order shown in Table 3b and showing mean knob volumes (0 - 5) at each of the 20 knob forming positions.

Collection No. and Country	The mean volume of knobs at 20 knob-forming positions																				Mean Knob Volume
	1S a	1S b	1L	2S	2L	3S	3L	4S	4L	5L	6L a	6L b	6L c	7S	7L	8L a	8L b	9S	9L	10L	
Guatemala																					
326	2.50	-	2.00	5.00	4.50	5.00	5.00	2.00	4.50	5.00	-	2.00	1.50	2.00	4.00	4.50	1.00	5.00	3.00	1.00	53.00
111	2.25	-	-	2.50	3.75	2.00	4.25	-	4.50	3.25	-	2.00	1.00	2.00	4.25	3.50	1.00	5.00	2.00	1.00	42.00
79	2.00	-	-	2.00	3.00	-	4.50	-	5.00	4.50	-	2.00	2.00	3.00	4.00	4.50	1.00	5.00	2.50	-	44.00
106	2.00	-	-	5.00	5.00	4.50	4.50	-	5.00	4.50	-	2.00	2.00	2.00	4.00	3.50	1.00	3.00	2.50	2.00	48.00
226	3.00	-	-	4.00	4.50	2.00	4.00	-	4.00	4.00	2.00	2.00	2.00	2.50	5.00	2.00	1.00	5.00	1.00	-	43.50
333	3.00	-	2.00	2.00	3.50	-	5.00	-	4.50	3.50	-	1.50	1.00	2.00	5.00	2.50	1.00	5.00	3.00	-	42.50
769	2.00	-	-	4.50	4.00	3.00	5.00	-	5.00	5.00	-	2.00	2.00	2.00	5.00	5.00	1.00	5.00	2.50	-	51.50
72	2.00	-	-	2.00	5.00	-	4.50	-	4.50	4.00	-	2.00	1.50	2.00	4.50	4.00	1.00	5.00	1.50	-	42.50
88	5.00	1.00	-	5.00	4.00	-	3.50	-	4.00	5.00	-	2.00	2.00	-	5.00	5.00	1.00	2.50	1.50	-	44.00
90	2.50	-	-	3.50	3.50	-	5.00	-	5.00	3.00	-	2.00	1.00	4.50	4.50	4.50	1.00	3.50	3.00	-	45.00
107	3.00	-	-	2.50	4.00	-	5.00	-	4.50	3.00	-	2.00	1.50	3.00	4.00	3.50	1.00	4.50	3.00	-	41.50
123	2.50	-	-	4.00	4.00	-	3.00	-	5.00	4.50	-	2.50	1.50	3.00	3.00	4.00	1.00	5.00	2.00	-	43.50
210	2.50	-	-	-	2.50	3.00	4.50	-	4.50	3.00	-	2.00	2.00	2.00	3.00	5.00	1.00	3.50	2.50	-	40.00
296	3.50	-	-	3.00	3.50	-	5.00	-	4.50	5.00	-	1.50	1.50	-	5.00	2.50	1.00	5.00	2.00	-	44.00
322	2.00	-	-	5.00	2.50	3.00	5.00	-	4.50	3.50	-	1.50	1.50	-	3.50	4.00	1.00	5.00	2.00	-	42.00
359	2.00	-	-	4.00	4.50	-	5.00	-	4.00	4.00	-	2.00	1.50	2.00	3.50	4.00	1.00	5.00	2.00	-	43.50
581	2.00	-	-	2.00	4.00	3.00	3.50	-	4.00	2.00	2.00	1.50	2.00	-	3.00	4.50	1.00	2.50	3.00	-	36.50
738	2.00	-	-	2.00	4.50	-	5.00	-	4.00	3.50	-	2.00	2.00	1.50	4.00	2.50	1.00	3.50	2.50	-	39.00
778	2.50	-	-	4.00	4.50	-	4.50	-	5.00	3.00	-	1.50	1.50	2.00	5.00	4.50	1.00	5.00	2.00	-	44.50
875	2.25	-	-	4.75	3.00	2.00	4.16	-	4.00	3.66	-	1.66	1.11	2.00	4.50	4.33	1.00	3.83	2.00	-	39.66
69	2.33	-	-	5.00	5.00	3.00	5.00	-	5.00	4.00	-	2.00	1.66	2.00	5.00	3.00	1.00	3.66	2.66	-	43.66
71	2.00	-	-	3.50	-	-	5.00	-	4.00	4.50	-	2.00	1.00	2.00	5.00	3.50	1.00	5.00	2.00	-	40.50
77	2.00	-	-	2.00	3.50	-	3.50	-	4.00	3.00	-	2.00	1.50	1.50	4.50	3.00	1.00	3.00	4.00	-	36.00
100	2.00	-	-	2.50	4.00	-	5.00	-	5.00	4.50	-	2.00	1.00	-	5.00	4.00	1.00	5.00	2.50	-	43.50
110	2.00	-	-	2.75	3.40	3.00	4.20	-	4.60	3.20	-	2.00	1.80	2.50	3.80	3.00	1.00	5.00	2.00	-	38.60
114	2.75	-	-	2.00	3.80	-	4.60	-	4.40	3.00	-	1.50	1.80	4.00	4.60	4.00	1.80	4.60	2.60	-	42.20
129	3.00	-	-	2.00	5.00	2.00	3.50	-	5.00	2.50	-	2.00	2.00	-	3.00	3.50	1.00	5.00	3.50	2.00	42.00
151	2.00	-	-	4.00	3.00	-	4.00	-	4.00	4.00	-	2.00	1.00	2.00	4.00	4.00	1.00	5.00	2.00	-	40.00
178	2.00	-	-	-	4.50	3.00	4.50	-	4.50	3.75	-	1.75	2.00	2.00	4.75	3.75	1.00	4.25	1.75	-	42.00
179	2.00	-	-	-	5.00	-	5.00	-	4.50	4.50	-	2.00	2.00	2.50	4.00	5.00	1.00	5.00	2.00	1.00	44.00
239	2.50	-	2.00	4.00	5.00	-	3.00	-	4.50	4.50	-	1.50	2.00	-	4.00	4.00	1.00	5.00	2.50	-	42.00
259	2.00	-	-	3.33	3.50	-	5.00	-	3.25	2.75	-	2.25	1.75	2.00	4.25	4.00	1.00	2.50	2.66	-	37.80
262	2.00	-	-	-	4.00	2.00	3.50	-	5.00	5.00	-	2.00	1.00	2.00	3.00	2.50	1.00	4.00	2.00	-	37.00
313	2.00	-	-	-	3.50	4.00	4.50	-	4.00	3.50	-	3.00	1.00	2.00	5.00	3.00	1.00	5.00	2.50	-	41.50
594	2.50	-	3.00	3.00	4.00	-	4.50	-	5.00	4.00	-	2.00	2.00	2.00	4.50	5.00	1.00	4.00	2.50	-	43.50
597	2.00	-	-	4.00	4.00	-	5.00	-	4.50	4.00	-	2.00	1.50	2.00	5.00	4.00	1.00	5.00	2.00	-	42.00
600	3.00	-	-	3.50	2.50	-	5.00	-	4.50	3.00	-	2.00	1.00	2.00	5.00	4.00	1.00	4.50	3.50	-	42.50
649	2.50	-	-	5.00	3.50	-	4.50	-	4.50	4.00	-	2.00	2.00	-	5.00	5.00	1.00	4.00	2.50	-	45.50
710	1.80	-	-	3.00	5.00	3.33	4.20	-	4.40	3.20	-	2.00	1.80	2.66	4.00	3.60	1.00	4.60	2.00	2.00	40.60
68	2.00	-	2.00	-	5.00	-	5.00	-	5.00	4.80	-	2.25	2.40	1.66	4.80	4.20	2.00	5.00	5.00	-	47.60
220	2.00	-	-	2.00	4.25	2.00	4.20	-	3.80	4.20	-	1.80	1.60	1.33	4.60	4.00	2.00	4.00	3.00	2.00	39.40
349	1.85	-	-	3.16	3.75	3.66	3.71	-	4.71	3.85	-	2.00	1.83	2.20	4.00	3.85	1.00	4.57	2.40	-	40.43
331	2.00	-	-	5.00	3.25	-	4.60	-	4.20	3.20	-	2.40	1.60	2.00	4.25	4.00	1.80	4.20	2.33	-	40.60
85	2.00	-	-	-	4.00	-	4.00	-	4.57	2.85	-	2.42	2.00	3.00	4.14	4.14	1.28	4.28	2.85	-	40.28
105	2.00	-	-	2.00	4.00	-	5.00	-	4.50	2.00	-	2.00	2.00	2.00	5.00	5.00	1.00	3.50	2.00	-	39.00

Collection No. and Country	The mean volume of knobs at 20 knob-forming positions																				Mean Knob Volume
	1S a	1S b	1L	2S	2L	3S	3L	4S	4L	5L	6L a	6L b	6L c	7S	7L	8L a	8L b	9S	9L	10L	
Guatemala																					
109	2.00	-	-	3.00	4.50	4.00	3.50	-	5.00	3.50	-	2.00	2.00	-	4.50	4.00	1.00	5.00	4.00	-	42.50
134	2.00	-	-	3.50	4.00	-	4.50	-	3.50	3.50	-	1.50	1.00	2.00	4.00	4.00	1.00	5.00	2.00	-	37.50
279	1.00	-	-	4.50	2.00	-	5.00	-	5.00	4.00	-	2.00	1.50	3.50	4.00	4.50	1.00	5.00	1.00	-	40.00
280	3.00	-	-	3.00	3.25	2.66	4.50	-	4.50	3.50	-	1.75	1.50	2.00	4.50	4.25	1.00	4.25	2.75	-	41.50
298	3.00	-	-	-	3.50	-	4.00	-	5.00	4.00	-	1.50	1.00	-	5.00	3.00	1.00	5.00	-	1.00	38.00
330	2.00	-	-	-	4.50	-	3.50	-	4.50	3.00	-	2.00	1.50	3.00	3.50	5.00	1.00	3.50	2.50	-	38.00
820	2.00	-	-	3.00	2.80	-	4.00	-	3.40	3.40	-	1.80	1.00	1.00	4.00	2.60	1.00	4.60	1.25	-	32.60
269	2.42	-	-	3.66	5.00	5.00	3.42	3.00	4.71	4.14	-	2.57	1.57	-	4.57	5.00	1.71	4.71	-	1.00	43.71
52	1.75	-	-	-	3.25	3.00	4.25	-	3.50	3.00	-	2.25	1.00	2.00	4.50	3.50	1.00	4.00	2.00	2.00	33.75
60	2.00	-	-	3.00	5.00	-	3.00	-	3.00	2.50	-	1.50	2.00	3.00	3.00	3.50	1.00	2.00	2.50	-	30.50
92	3.00	-	-	-	3.50	-	4.50	-	5.00	3.00	-	3.00	2.00	3.00	5.00	4.50	1.00	4.50	2.50	-	42.00
103	2.00	-	-	3.00	3.00	3.00	4.00	-	4.50	4.00	-	1.50	2.00	-	3.00	3.50	1.00	5.00	2.00	-	36.00
108	2.00	-	-	4.00	4.00	-	3.50	-	3.50	4.50	-	1.50	2.00	-	5.00	5.00	1.00	5.00	2.00	-	40.00
116	2.50	-	-	4.00	4.00	4.00	4.00	-	4.00	3.00	-	1.50	2.00	-	4.50	2.50	1.00	4.50	-	-	38.50
135	2.00	-	-	3.00	3.50	3.00	5.00	-	5.00	4.50	-	2.00	2.00	-	4.50	3.00	1.00	4.50	-	-	38.50
145	2.40	-	-	-	5.00	-	5.00	-	5.00	3.60	-	3.20	1.80	2.20	4.80	4.20	1.20	5.00	4.00	-	45.00
148	3.00	-	-	2.00	3.50	-	3.50	-	5.00	3.50	-	2.00	1.50	2.00	4.00	3.50	1.00	4.50	-	-	34.00
155	2.00	-	-	-	3.00	-	5.00	-	4.00	3.50	-	2.00	2.00	-	3.00	4.00	1.00	5.00	2.00	-	36.50
158	2.00	-	-	1.00	2.80	-	4.40	-	4.40	3.60	-	2.00	2.00	-	3.80	4.40	1.80	5.00	2.00	-	37.60
160	2.00	-	-	5.00	4.00	-	5.00	-	4.50	5.00	2.00	2.00	2.00	2.00	5.00	4.50	1.00	4.50	3.00	-	44.50
164	2.00	-	-	2.00	3.00	-	4.50	-	4.00	2.50	-	1.50	1.50	-	4.50	2.50	-	4.50	2.00	1.00	33.00
229	2.00	-	-	-	4.50	-	4.50	-	3.50	3.00	-	2.00	1.50	2.00	4.00	5.00	1.00	2.00	2.00	1.00	35.00
253	3.00	-	-	-	3.00	-	5.00	-	4.50	3.00	-	2.00	2.00	2.00	3.50	5.00	1.00	5.00	4.00	-	39.50
260	2.50	-	-	-	3.00	-	4.50	-	5.00	4.00	-	2.00	1.50	2.00	2.50	4.50	1.00	4.00	2.00	-	36.50
314	2.00	-	-	4.00	4.50	-	3.00	-	4.50	4.00	-	1.00	2.00	3.00	3.00	3.00	1.00	-	3.00	-	34.50
316	2.00	-	-	3.00	4.00	-	3.50	-	4.00	4.50	-	1.50	1.50	2.00	5.00	5.00	1.00	4.00	2.00	-	38.50
426	2.00	-	-	3.00	3.50	2.00	3.50	-	4.00	4.00	-	2.00	-	-	4.50	2.50	1.00	5.00	3.00	-	37.50
744	1.66	-	-	2.00	3.66	-	4.00	-	3.00	4.66	-	2.00	2.00	2.00	4.66	4.33	1.00	4.66	2.00	-	38.66
793	2.00	-	-	2.00	3.00	-	4.50	-	5.00	4.00	-	1.50	2.00	2.00	5.00	2.50	1.00	5.00	-	-	37.50
120	2.00	-	-	3.00	4.00	-	4.00	-	4.50	3.50	-	2.00	1.66	3.00	4.00	4.25	1.00	3.25	1.00	-	37.25
765	2.50	-	-	2.25	4.12	-	4.50	-	4.87	3.87	-	2.12	1.16	2.00	5.00	3.12	1.12	4.87	2.00	-	39.25
133	2.66	-	-	3.00	3.33	-	3.66	-	5.00	3.33	-	2.33	1.50	-	4.66	3.66	1.00	3.66	-	-	38.00
207	2.00	-	-	2.00	4.00	3.00	4.60	-	4.80	3.40	-	2.25	1.80	2.00	4.60	3.40	2.00	5.00	3.00	-	39.40
329	2.14	-	-	3.00	3.00	-	4.44	-	4.88	4.00	-	2.00	2.00	3.00	3.88	4.22	1.22	4.77	5.00	-	39.33
4	2.00	-	-	3.00	3.50	3.00	5.00	-	4.00	3.50	-	1.00	2.00	-	4.00	2.00	1.00	5.00	-	-	35.50
20	2.00	-	2.00	3.00	5.00	-	3.00	-	5.00	3.00	-	2.00	2.50	-	4.00	2.50	-	4.00	2.00	-	36.00
81	2.00	-	-	-	3.00	-	4.50	-	5.00	5.00	-	2.00	1.00	1.00	3.50	4.00	1.00	2.00	2.50	-	35.00
143	2.50	-	-	2.00	5.00	-	5.00	-	5.00	4.50	-	2.00	2.00	-	5.00	3.50	1.00	4.00	-	-	40.50
174	2.00	-	-	-	5.00	-	5.00	-	5.00	4.50	-	2.00	1.50	2.00	4.50	4.50	1.00	3.50	-	-	39.00
321	2.00	-	-	-	4.00	3.00	4.00	-	4.50	5.00	-	1.50	2.00	-	4.00	5.00	1.00	4.00	-	-	38.50
338	3.00	-	-	1.00	4.00	-	4.00	-	4.00	5.00	-	2.00	1.50	-	4.50	4.50	1.00	3.00	-	1.00	35.00
351	2.00	-	-	4.00	4.50	-	5.00	-	3.00	3.00	-	2.00	1.00	-	3.50	3.00	1.00	4.00	2.00	-	33.00
529	2.00	-	-	2.00	4.50	-	3.50	-	5.00	3.50	-	1.00	2.00	-	5.00	4.00	-	2.50	2.50	-	36.50
573	2.00	-	-	2.00	4.14	5.00	5.00	-	3.71	2.57	-	2.00	1.00	2.75	3.57	3.28	1.00	3.14	2.00	-	32.71

Collection	The mean volume of knobs at 20 knob-forming positions																				Mean
No. and Country	1S a	1S b	1L	2S	2L	3S	3L	4S	4L	5L	6L a	6L b	6L c	7S	7L	8L a	8L b	9S	9L	10L	Knob Volume
Guatemala																					
760	2.00	-	-	-	5.00	-	3.00	-	5.00	4.00	-	2.00	2.00	2.00	4.50	5.00	1.00	4.50	-	-	38.50
821	2.00	-	-	3.00	3.00	-	3.00	-	3.50	4.00	-	1.50	1.00	-	4.50	3.00	1.00	3.50	2.00	-	31.00
937	2.00	-	-	2.00	2.00	-	3.50	-	5.00	2.00	-	2.00	1.00	-	5.00	5.00	1.00	1.50	1.00	-	30.50
281	1.33	-	-	-	3.80	-	3.80	-	4.60	4.00	4.00	2.00	2.00	3.50	4.80	3.75	2.00	4.25	2.50	-	37.40
500	2.20	-	-	1.75	3.50	-	4.80	-	4.40	2.80	-	2.00	2.00	-	5.00	3.80	1.40	5.00	2.33	-	35.80
161	2.16	-	-	2.00	3.00	2.00	4.83	-	4.00	3.14	2.00	2.00	2.00	-	3.85	3.60	1.40	3.71	2.00	1.50	33.00
87	2.00	-	-	-	4.50	-	5.00	-	5.00	3.00	-	2.00	1.50	2.00	5.00	4.00	1.00	3.50	-	-	37.00
115	2.50	-	-	3.00	5.00	-	5.00	-	5.00	5.00	-	2.00	2.00	-	2.50	5.00	1.00	2.00	-	-	37.50
231	2.50	-	-	-	3.00	-	2.50	-	3.00	5.00	-	2.00	2.00	2.00	5.00	4.00	1.00	5.00	2.00	-	35.50
242	2.50	-	-	-	4.00	-	-	-	5.00	3.50	-	2.00	1.00	2.00	5.00	3.50	1.00	3.00	-	-	32.50
344	2.00	-	-	4.00	4.00	-	5.00	2.00	5.00	3.00	-	2.00	-	2.00	4.50	3.75	1.00	4.00	2.00	-	36.75
552	2.00	-	-	5.00	3.33	-	5.00	-	4.00	3.50	-	1.33	1.50	-	5.00	4.00	1.00	5.00	2.00	-	37.66
809	3.50	-	-	-	5.00	-	5.00	-	4.00	2.00	-	2.00	1.00	-	2.50	3.00	1.00	3.50	3.00	-	33.50
131	2.00	-	-	-	3.80	-	4.20	-	4.40	2.60	-	2.00	1.75	-	4.40	3.40	1.20	4.40	2.00	-	33.60
130	2.75	-	-	2.50	3.80	-	3.60	-	4.20	3.20	-	2.33	1.50	-	4.20	3.20	1.50	4.60	3.00	-	34.80
603	-	-	-	2.50	5.00	-	4.00	-	4.00	2.50	-	2.00	1.50	-	4.00	3.00	1.00	4.00	-	-	31.00
74	2.50	-	-	-	-	-	4.50	-	5.00	3.50	-	2.00	1.50	-	4.00	5.00	1.00	5.00	1.00	-	34.00
225	2.50	-	-	-	4.00	-	4.50	-	3.50	2.50	-	2.00	1.00	-	2.50	4.00	1.00	-	-	-	27.50
459	1.50	-	-	2.00	3.00	-	5.00	-	4.50	4.50	-	2.00	1.00	-	3.50	2.50	1.00	5.00	-	-	30.00
473	2.00	-	-	-	5.00	-	5.00	-	5.00	4.50	-	2.00	1.00	-	5.00	2.00	1.00	-	-	-	32.50
544	1.00	-	-	-	2.50	-	2.00	-	4.00	2.00	-	1.50	1.00	-	2.50	3.00	1.00	1.00	-	-	20.50
591	-	-	-	3.00	2.00	-	2.00	-	-	1.50	-	2.00	2.00	-	3.00	3.00	1.00	1.50	3.00	-	23.00
642	2.50	-	-	2.00	3.00	-	3.00	-	-	5.00	2.00	1.00	1.00	-	4.00	3.50	-	1.00	1.00	-	24.00
806	1.00	-	-	-	4.50	-	5.00	-	4.50	2.50	-	2.00	-	-	4.50	2.50	1.50	3.50	-	-	31.50
448	2.20	-	-	2.00	3.66	-	3.25	-	4.00	3.80	-	2.00	1.20	-	2.20	2.00	1.00	3.33	-	-	24.40
651	2.00	-	-	-	2.66	-	5.00	-	3.00	3.00	-	1.00	2.00	-	3.66	2.50	1.00	4.00	2.00	1.00	25.66
320	2.00	-	-	-	3.00	-	-	-	4.50	3.00	-	2.00	1.50	2.00	4.50	4.00	1.00	-	2.00	-	26.00
539	2.00	-	-	2.00	3.00	-	2.00	-	3.50	2.50	-	1.00	1.00	-	3.00	2.00	-	2.00	-	-	21.50
635	2.00	-	-	2.00	-	-	-	-	3.66	2.33	-	1.66	1.66	-	3.66	2.33	-	2.33	1.00	-	22.33
209	1.66	-	-	-	4.25	-	3.00	-	3.75	3.00	-	2.25	1.00	-	4.00	3.50	-	3.75	2.00	-	28.25
257	-	-	2.50	3.00	-	-	-	-	4.33	3.00	-	2.00	2.00	2.00	3.00	3.00	1.00	2.00	-	-	23.33
508	2.00	-	-	3.00	3.50	-	5.00	-	2.00	4.00	-	-	1.00	-	2.00	3.50	1.00	5.00	-	-	26.50
746	-	-	-	-	3.50	-	3.00	-	3.00	2.50	-	-	3.00	-	4.00	2.50	-	1.50	1.00	-	24.00
841	-	-	-	5.00	4.00	-	-	-	4.50	4.50	-	2.00	1.00	-	5.00	4.00	1.00	5.00	4.00	-	33.00
27	2.00	-	-	2.00	5.00	-	2.00	-	3.66	2.66	-	1.50	2.00	3.00	4.00	3.00	1.00	4.00	-	-	24.00
187	2.00	-	-	2.00	3.00	-	-	-	4.00	2.50	-	1.00	1.50	2.00	4.00	3.00	-	2.00	-	-	21.50
477	2.00	-	-	-	2.00	-	3.00	-	4.00	2.50	-	1.00	1.00	-	2.50	2.00	-	1.00	1.00	-	18.50
576	2.00	-	-	-	2.00	-	2.00	-	2.00	3.00	-	1.50	2.00	-	3.00	2.00	1.00	2.00	-	-	17.50
577	2.00	-	-	-	3.00	-	2.00	-	2.50	2.50	-	1.00	-	-	2.50	2.00	-	1.50	-	1.00	18.00
393	2.00	-	-	-	-	-	4.50	-	4.00	4.00	-	-	2.00	-	3.00	3.50	1.00	3.00	-	-	24.50
637	2.00	-	-	-	-	-	2.00	-	3.50	2.00	-	1.00	1.00	-	3.00	2.00	-	2.00	3.00	-	18.00
678	2.00	-	-	-	-	-	-	-	1.00	3.00	-	2.00	1.00	-	2.00	3.00	1.00	-	-	-	15.00
704	-	-	-	-	4.50	-	-	-	4.00	3.50	-	1.00	-	-	2.50	4.00	1.00	-	1.00	-	21.50
944	-	-	-	3.00	5.00	-	2.50	-	4.00	2.00	-	-	2.00	-	3.50	2.00	-	2.00	-	-	23.50
455	2.00	-	-	2.00	4.00	-	2.00	-	-	2.50	-	1.00	1.00	-	2.50	2.00	-	5.00	-	-	18.00

Collection No. and Country	The mean volume of knobs at 20 knob-forming positions 1S a	1S b	1L	2S	2L	3S	3L	4S	4L	5L	6L a	6L b	6L c	7S	7L	8L a	8L b	9S	9L	10L	Mean Knob Volume
Guatemala																					
705	-	-	-	2.00	4.00	-	3.00	-	-	2.50	-	2.00	-	-	3.50	3.50	1.00	2.50	-	-	20.00
31	2.00	-	-	-	-	-	2.00	-	2.00	2.50	-	-	-	-	3.00	2.00	-	2.00	2.00	-	15.50
480	2.00	-	-	2.00	3.00	-	2.50	-	-	2.00	-	-	-	-	3.00	2.00	-	1.50	-	-	14.50
590	1.00	-	-	2.00	-	-	-	-	4.00	4.50	2.00	2.00	2.00	-	3.00	2.00	-	3.00	-	-	19.50
908	2.33	-	-	-	4.00	-	2.00	-	-	3.66	-	1.00	-	-	2.00	2.00	1.00	1.50	-	1.00	14.00
583	-	-	-	2.00	3.00	-	-	-	4.00	2.50	-	1.00	1.00	-	3.00	4.00	-	4.00	-	-	16.00
382	2.00	-	-	-	-	-	1.50	-	3.00	2.00	-	-	-	-	3.00	1.00	-	3.00	-	-	12.50
497	-	-	-	1.00	1.50	-	-	-	-	2.50	-	-	-	2.00	3.00	-	1.00	2.50	-	-	11.00
924	2.00	-	-	-	-	-	2.50	-	4.00	2.50	-	-	-	-	2.50	3.50	1.00	-	-	-	15.50
742	1.00	-	-	3.00	-	-	3.00	-	-	2.33	-	-	-	-	2.33	-	1.00	2.00	-	1.00	11.66
647	-	-	2.00	-	2.00	-	2.00	-	-	2.80	-	1.50	2.00	-	3.20	2.50	2.00	3.80	1.00	-	14.80
835	2.00	-	-	-	2.00	-	-	-	1.75	2.40	-	1.50	1.00	-	2.60	2.00	1.00	-	-	1.66	10.80
465	1.00	-	-	-	4.00	-	2.50	-	-	2.00	-	-	-	-	2.00	-	1.00	2.00	-	1.00	11.50
596	-	-	-	-	-	-	2.00	-	-	3.00	-	-	-	-	2.00	2.00	1.00	1.00	-	-	10.50
8	-	-	-	-	-	-	-	-	4.00	3.00	-	-	-	-	2.00	2.00	1.00	-	-	-	12.00
431	-	-	-	-	-	-	2.00	-	-	2.00	-	-	-	-	2.00	2.00	1.00	2.00	-	-	9.50
522	-	-	-	1.00	-	-	4.00	-	4.00	1.50	-	-	1.00	-	2.00	-	-	-	-	-	11.00
607	-	-	-	-	-	-	-	-	-	2.00	-	1.00	-	-	5.00	2.50	-	2.50	-	-	13.00
619	-	-	-	2.00	2.00	-	1.00	-	4.00	3.00	-	-	-	-	2.00	-	-	-	-	-	11.50
22	2.00	-	-	2.00	2.00	-	-	-	2.00	2.60	-	-	-	-	3.60	-	1.66	1.00	-	-	10.80
461	2.00	-	-	-	-	-	5.00	-	2.00	2.00	-	-	-	-	2.00	1.00	-	1.00	-	-	9.50
674	-	-	-	-	-	-	-	-	-	2.00	-	-	2.00	-	2.00	3.00	1.00	-	-	-	8.50
909	-	-	-	-	2.00	-	2.50	-	-	2.00	-	-	-	-	2.50	-	1.00	3.00	-	-	10.00
934	1.50	-	-	-	2.00	-	-	-	-	2.50	-	1.00	-	-	2.50	2.00	-	-	-	-	10.00
852	2.00	-	-	-	3.50	-	3.50	-	5.00	3.00	-	-	1.00	-	4.40	2.00	1.00	-	-	2.00	13.00
458	-	-	-	2.00	1.00	-	1.00	-	-	2.33	-	1.00	-	-	1.57	1.66	1.00	1.66	-	2.00	6.43
386	-	-	-	-	3.00	-	3.50	-	-	2.00	-	-	-	-	3.00	-	1.00	2.00	-	-	10.50
413	2.00	-	-	-	-	-	3.00	-	-	2.00	-	-	-	-	2.50	-	1.00	3.00	-	-	9.00
513	-	-	-	-	-	-	2.00	-	-	1.50	-	-	1.00	-	2.00	-	1.00	2.00	-	-	6.50
895	-	-	-	-	2.00	-	-	-	2.00	2.00	-	-	-	-	1.50	-	-	3.00	-	1.00	8.00
492	-	-	-	-	2.00	-	1.00	-	-	3.00	-	1.00	-	-	1.00	-	1.00	-	-	-	5.00
902	2.50	-	-	-	-	-	-	-	2.00	3.00	-	-	-	-	2.50	-	-	-	-	-	9.00
491	-	-	-	3.00	2.00	-	-	-	-	2.00	-	1.00	-	-	2.66	-	1.00	1.00	-	-	6.66
37	2.00	-	-	-	-	-	-	-	-	4.00	-	-	-	-	2.00	-	-	-	-	-	8.00
427	-	-	-	-	-	-	-	-	-	2.00	-	-	-	-	2.50	2.00	-	-	-	-	6.50
564	-	-	-	-	-	-	3.00	-	-	3.00	-	-	-	-	2.50	-	-	2.00	-	-	8.00
423	2.00	-	-	-	-	-	-	-	1.00	-	-	1.00	-	-	2.00	-	-	-	-	-	4.00
14	-	-	-	-	2.00	-	-	-	-	2.00	-	-	-	1.00	-	-	-	-	-	-	3.50
El Salvador																					
71J	3.00	-	2.00	2.33	2.40	2.50	4.00	-	3.50	3.20	-	1.80	1.75	-	4.60	4.40	1.00	4.80	2.33	-	39.60
13J	2.25	-	-	3.00	3.00	2.50	3.60	-	4.80	3.80	-	2.20	1.40	2.00	4.60	3.60	1.00	4.80	2.25	2.00	39.80
30J	2.00	-	-	3.00	4.00	4.00	4.25	-	4.40	4.00	2.00	1.80	1.75	2.00	4.80	2.80	1.00	4.80	2.00	-	39.60
9	3.00	-	2.00	4.25	4.80	-	4.80	-	4.80	4.60	-	2.75	2.25	-	5.00	4.80	2.00	5.00	4.00	-	50.00
65J	3.50	-	2.00	-	3.20	2.00	4.00	-	5.00	4.40	-	2.00	1.20	2.00	4.40	3.00	1.00	4.80	3.00	-	37.60

Collection No. and Country	The mean volume of knobs at 20 knob-forming positions																				Mean Knob Volume
	1S a	1S b	1L	2S	2L	3S	3L	4S	4L	5L	6L a	6L b	6L c	7S	7L	8L a	8L b	9S	9L	10L	
El Salvador																					
59J	2.00	-	-	2.00	4.75	-	4.25	-	4.80	2.60	-	2.00	1.00	2.00	4.00	4.00	1.00	4.20	2.00	1.00	34.80
6J	3.00	-	-	2.75	3.00	3.50	3.50	-	4.20	2.00	-	2.00	1.40	-	4.20	1.80	1.00	2.80	3.00	-	30.00
29	2.00	-	3.00	4.50	4.00	2.00	4.60	-	4.60	4.40	-	2.40	1.67	-	5.00	4.60	2.00	5.00	2.00	-	41.60
54J	2.00	-	-	2.00	4.00	-	4.20	-	5.00	2.40	-	1.75	1.75	2.00	4.60	4.00	1.00	4.80	-	-	34.80
Honduras																					
76J	2.50	-	2.00	3.40	4.00	2.00	3.40	-	4.60	3.60	-	1.80	1.20	2.00	4.20	3.60	1.00	4.60	2.00	-	42.60
78J	2.80	-	1.00	3.25	3.60	2.25	3.20	2.00	3.60	3.40	-	1.80	2.00	2.00	4.00	3.80	1.00	3.75	3.25	2.00	40.60
66J	2.40	-	2.00	3.50	2.80	2.00	2.40	2.00	4.60	3.80	-	1.40	2.00	2.00	4.00	3.00	1.00	4.00	1.50	-	38.40
6J	2.00	-	2.33	3.20	3.60	3.33	3.20	2.00	3.00	3.60	-	1.80	1.50	2.00	3.80	2.80	1.00	5.00	2.00	-	39.60
15J	3.00	-	2.00	2.25	4.00	2.00	4.40	-	4.40	3.40	-	2.00	1.00	2.40	4.80	4.20	1.00	4.60	2.00	-	43.20
10J	2.40	-	2.00	3.20	4.20	3.00	4.40	2.00	4.40	2.80	-	2.00	1.00	-	4.20	3.00	1.00	3.80	2.80	-	41.20
55J	3.80	-	2.00	3.00	4.60	3.00	4.80	-	4.20	3.40	-	1.75	2.80	-	4.20	3.20	1.00	4.40	3.60	-	44.60
83J	2.20	-	-	3.67	3.20	3.25	4.00	2.00	4.60	3.60	-	2.00	1.75	2.00	4.60	3.80	1.00	4.00	2.00	-	42.00
50J	2.60	-	2.00	2.80	2.40	2.33	4.40	2.00	4.00	3.40	-	2.00	1.60	2.00	4.80	4.80	1.00	4.20	2.00	-	41.40
82J	2.20	-	-	3.25	2.40	3.50	3.40	-	4.20	4.40	-	2.00	1.60	-	4.00	3.60	1.00	3.20	1.25	-	37.00
62J	2.60	-	-	3.40	4.50	2.50	3.80	2.67	3.20	2.80	-	2.00	1.20	2.00	3.20	3.85	1.00	3.33	2.00	-	35.40
102J	2.20	-	-	3.00	4.50	3.00	4.00	-	4.20	4.00	-	2.00	1.40	2.00	4.20	2.40	1.00	5.00	2.33	-	40.00
7J	2.00	-	2.00	2.60	3.00	2.00	3.00	-	4.50	3.20	2.00	2.20	1.40	-	4.20	3.80	1.00	5.00	2.00	-	36.80
14J	2.80	-	-	2.75	2.50	-	3.00	-	3.80	2.50	2.00	2.00	1.40	-	4.00	3.20	1.00	2.20	2.00	2.00	31.80
12J	2.40	-	-	2.33	3.20	-	4.20	-	4.20	3.00	-	2.00	1.20	-	3.60	3.40	1.00	2.20	2.50	-	33.60
21J	2.75	-	2.00	2.00	4.00	-	4.00	3.00	3.60	4.00	-	2.00	1.40	-	5.00	3.20	1.00	4.80	1.50	-	36.40
32J	2.80	-	-	2.67	4.40	-	4.25	-	4.20	3.60	3.00	2.20	1.75	2.00	4.00	4.20	1.00	3.60	2.00	-	39.00
41J	2.20	-	-	-	4.00	-	3.20	-	3.40	3.60	-	1.80	1.20	-	2.40	2.33	1.00	3.20	3.00	2.00	29.40
3J	2.25	-	-	2.50	3.75	-	4.75	-	2.75	3.40	-	1.50	1.80	-	4.40	2.20	1.00	3.80	2.00	-	30.40
20J	2.25	-	-	-	3.00	-	3.75	-	4.25	2.75	-	2.00	1.25	-	4.00	4.25	1.00	2.50	1.00	2.00	28.00
5J	2.00	-	-	-	4.20	-	3.75	-	4.20	3.00	-	1.75	1.33	-	3.60	3.00	1.00	3.00	3.00	-	29.20
Nicaragua																					
3445	2.20	2.00	2.00	2.00	3.80	2.33	3.60	-	5.00	3.40	-	1.60	1.60	2.00	4.80	4.20	1.00	5.00	1.50	-	42.00
3401	3.00	-	-	3.40	2.40	-	4.20	2.00	4.20	4.40	-	2.20	1.60	2.00	3.40	4.00	1.00	3.80	1.80	-	40.80
3429	2.20	-	-	4.00	2.20	-	5.00	2.00	3.80	3.00	-	2.00	1.00	2.00	4.20	4.20	1.00	3.80	2.25	-	39.00
3424	2.20	-	-	2.20	4.40	2.50	4.40	2.00	4.60	3.60	-	2.00	1.00	2.00	3.80	3.80	1.00	5.00	2.00	-	40.80
3380	3.20	-	-	3.00	3.00	2.00	3.80	-	4.40	3.40	-	2.00	1.20	2.00	4.20	2.80	1.00	4.60	2.25	-	37.20
3432	2.20	-	2.00	3.50	2.80	4.00	3.40	-	4.00	2.60	-	2.20	2.50	2.00	3.80	3.20	1.00	3.75	2.00	-	35.40
2	2.00	-	-	4.00	4.20	2.00	5.00	-	5.00	3.40	-	2.00	1.20	2.00	4.80	3.40	1.00	5.00	2.00	-	41.00
33	2.60	-	2.00	5.00	4.00	2.00	3.00	-	4.40	3.80	-	3.20	1.40	2.00	5.00	4.20	2.00	4.60	2.00	-	42.00
3449	2.40	-	3.00	3.00	3.20	3.00	3.60	-	4.00	3.20	-	2.00	1.50	-	4.60	3.00	1.00	3.40	2.00	-	35.80
3378	2.00	-	-	2.00	3.25	-	3.60	-	2.60	3.20	-	2.00	1.00	-	3.60	3.80	1.00	5.00	2.00	-	31.60
3406	2.80	-	-	2.75	3.50	-	4.00	-	4.25	2.80	-	2.00	1.60	-	4.00	3.80	1.00	3.40	2.00	-	32.60
3357	2.00	-	-	2.00	3.80	-	3.00	-	3.20	2.40	-	1.60	1.00	-	4.80	3.00	1.00	3.20	1.75	-	29.80
3411	1.75	-	-	2.00	3.00	3.50	3.10	-	4.00	3.00	-	2.00	1.00	-	3.60	3.60	1.00	2.75	2.00	-	28.60
Costa Rica																					
107	2.00	-	-	3.00	2.80	3.20	4.60	2.00	4.20	3.00	-	2.00	1.20	2.00	4.40	3.80	1.00	5.00	1.80	-	42.80
166	2.60	-	2.00	3.80	3.50	3.25	5.00	2.00	4.60	3.60	-	1.80	1.20	2.00	4.40	3.40	1.00	4.50	3.00	-	44.00

Collection No. and Country	The mean volume of knobs at 20 knob-forming positions																				Mean Knob Volume
	1S a	1S b	1L	2S	2L	3S	3L	4S	4L	5L	6L a	6L b	6L c	7S	7L	8L a	8L b	9S	9L	10L	
Costa Rica																					
379	2.20	–	2.00	2.80	2.80	3.33	3.00	2.00	3.60	2.60	–	2.00	1.60	–	4.00	3.00	1.00	4.50	1.80	2.00	37.20
380	2.00	–	2.00	5.00	3.20	3.00	3.20	2.00	3.20	3.20	–	2.00	1.60	2.00	5.00	3.00	1.00	5.00	3.00	–	41.00
58	2.20	–	–	3.00	2.80	5.00	3.60	2.00	4.80	4.00	–	1.80	1.00	2.00	4.20	3.60	1.40	4.20	3.50	–	40.80
182	2.20	–	–	2.40	2.40	2.00	4.00	2.00	3.60	2.80	–	2.00	1.40	2.00	4.20	3.40	1.00	4.80	2.33	–	37.60
92	2.00	–	2.00	3.00	3.00	2.00	3.20	2.00	3.40	3.20	–	2.20	1.40	2.00	4.00	4.40	1.00	3.80	2.67	–	37.00
296	2.00	–	–	3.20	2.20	3.33	3.80	–	4.80	2.60	–	2.20	1.25	2.00	3.80	3.00	1.00	3.40	2.00	–	36.60
138	2.20	–	–	3.00	2.60	1.50	3.80	2.00	3.60	2.60	–	2.00	2.00	2.00	4.80	3.40	1.00	5.00	2.67	–	37.60
97	2.40	–	–	3.75	4.00	–	3.20	2.00	3.80	2.00	–	2.00	1.60	2.00	3.80	4.00	1.00	3.60	2.00	–	36.40
135	2.00	–	–	3.00	2.20	2.33	3.40	–	4.20	2.80	–	1.75	2.00	2.00	3.80	2.80	1.00	4.80	2.00	–	35.60
114	1.75	–	–	2.40	2.40	2.50	3.40	–	4.40	3.20	–	2.00	1.67	2.00	3.20	3.20	1.00	4.60	3.00	–	34.60
103	2.00	–	–	4.00	3.40	2.00	3.40	–	4.40	2.20	–	1.80	1.00	–	4.40	1.60	1.00	4.00	2.50	–	33.40
63	2.00	–	–	2.00	2.75	3.67	2.60	–	3.60	2.40	–	2.00	1.50	2.00	4.00	3.00	1.00	4.20	1.67	–	32.00
5	2.00	–	–	3.33	4.00	2.00	3.80	2.00	4.20	2.80	–	2.00	1.75	2.50	3.80	2.60	1.00	5.00	1.75	1.00	32.40
71	2.00	–	–	2.25	3.00	–	3.40	–	3.40	2.80	–	2.00	1.00	2.00	4.00	2.80	1.00	4.20	3.20	–	32.00
86	2.00	–	3.00	2.00	3.60	–	3.50	2.00	3.20	3.40	–	1.80	1.20	–	3.00	4.00	1.00	3.80	3.00	–	30.80
59A	2.80	–	–	–	3.50	–	4.00	–	4.40	2.20	–	1.80	1.25	2.00	3.80	3.20	1.00	5.00	1.50	–	33.00
22	2.25	–	–	3.00	2.75	2.00	4.20	–	2.80	3.00	–	1.75	1.00	2.00	3.60	3.00	1.00	4.00	1.50	–	30.60
59	2.00	–	–	2.00	2.60	–	2.40	–	3.00	2.00	–	2.00	1.75	2.00	3.00	4.20	1.00	4.75	3.00	–	29.20
280	2.25	–	–	2.67	3.00	2.00	3.40	–	3.40	2.00	–	1.80	1.80	–	2.80	2.80	1.20	3.50	2.00	–	27.80
45	2.50	–	–	2.80	2.67	–	3.60	–	4.00	3.80	–	2.00	1.67	–	3.40	2.60	1.20	5.00	–	–	32.00
37	2.00	–	1.00	2.50	2.00	3.00	4.40	–	3.80	2.20	–	2.20	1.25	–	4.60	4.20	1.00	1.50	2.50	–	29.60
26	2.00	–	–	2.67	3.00	3.00	2.00	–	4.50	2.40	–	2.00	1.20	2.00	4.40	4.40	1.00	4.00	2.67	–	29.20
42	2.00	–	–	2.67	2.67	2.00	3.20	–	3.00	2.00	–	2.00	2.00	–	3.20	3.60	1.00	2.50	2.00	–	26.40
95	3.60	–	–	–	3.20	1.00	3.80	–	3.20	2.40	–	2.00	2.00	2.00	3.80	3.00	1.00	2.00	3.00	–	28.60
254	2.00	–	–	2.00	2.50	–	3.00	–	3.20	2.25	–	1.00	1.20	–	2.80	2.80	1.00	1.00	2.00	–	22.00
279	2.00	–	–	2.50	3.50	–	2.60	–	3.80	2.80	–	1.80	1.25	–	2.80	2.75	1.00	3.00	2.00	–	24.40
315	2.20	–	–	2.00	2.75	–	4.00	–	3.00	2.40	–	2.00	1.00	–	3.80	2.33	1.00	4.00	3.00	–	25.60
400	2.00	–	2.00	3.50	2.67	–	3.33	2.00	3.00	2.00	–	2.00	1.20	–	3.25	2.75	1.00	2.67	3.00	–	22.40
11	1.50	–	–	3.00	3.00	–	1.80	–	2.00	2.80	–	1.50	1.00	–	1.60	3.33	1.00	4.67	2.33	2.00	20.20
12	1.00	–	–	2.40	–	–	1.50	–	3.60	2.40	–	2.00	1.60	–	2.00	2.20	1.00	1.67	1.50	–	19.00
345	2.67	–	–	2.00	5.00	–	3.67	–	–	2.00	–	2.00	1.50	–	2.00	4.00	–	4.50	2.00	–	23.30
18	2.00	–	2.00	–	2.25	–	3.75	–	2.00	2.00	–	1.00	1.25	–	3.00	2.50	1.00	1.67	–	–	16.80
334	2.00	–	–	2.00	–	–	3.40	–	4.00	2.25	–	1.67	1.00	–	2.00	3.20	1.00	2.00	–	–	13.60
Panama																					
2B	3.20	–	–	4.20	4.33	4.50	4.80	–	4.60	4.80	–	2.20	1.40	2.50	4.20	5.00	1.40	5.00	4.40	–	53.60
5P	3.40	–	5.00	5.00	3.60	4.33	4.00	–	4.80	4.00	–	2.40	2.20	–	4.80	5.00	1.40	4.40	4.00	–	49.00
18B	2.00	–	–	2.00	5.00	2.08	3.60	–	4.80	3.00	–	2.50	2.20	2.00	4.20	3.75	1.00	4.40	2.00	2.00	39.20
12M	2.00	–	–	3.00	4.00	2.50	2.50	2.00	4.20	4.20	–	1.80	1.20	–	3.80	4.60	1.00	3.80	2.20	–	38.00
3Q	2.00	–	–	4.00	3.50	2.00	3.00	–	4.75	2.00	–	2.00	2.50	–	3.25	3.50	1.25	4.25	3.00	–	34.50
11M	2.00	–	–	2.00	2.75	3.00	3.40	–	3.80	2.20	–	2.00	1.00	–	5.00	3.40	1.00	4.40	4.50	–	36.80
20M	2.00	–	–	3.00	2.75	4.00	4.00	–	3.80	3.20	–	2.00	1.00	2.00	4.00	5.00	–	4.20	3.25	–	39.20
39P	2.00	–	–	2.75	1.33	2.33	3.60	–	4.00	2.40	–	2.80	1.25	2.00	4.00	2.60	1.20	4.25	4.50	–	31.60
2C	2.50	–	–	–	4.80	–	4.60	2.00	5.00	4.60	–	1.75	1.75	3.00	4.60	4.60	1.00	3.40	4.00	–	40.80
31B	2.00	–	–	3.33	4.67	–	5.00	–	5.00	4.40	–	3.20	1.60	2.00	4.60	4.20	1.00	4.00	4.00	–	40.40
23P	2.00	1.00	2.00	–	4.20	–	4.50	–	4.80	4.00	–	1.75	1.80	–	4.80	3.80	1.75	5.00	2.00	–	37.40

Collection No. and Country	The mean volume of knobs at 20 knob-forming positions																				Mean Knob Volume
	1S a	1S b	1L	2S	2L	3S	3L	4S	4L	5L	6L a	6L b	6L c	7S	7L	8L a	8L b	9S	9L	10L	
Panama																					
35P	4.00	-	-	3.00	2.80	5.00	5.00	-	3.60	2.50	-	1.80	1.00	-	4.00	3.20	1.00	3.67	3.40	-	31.40
12P	2.00	-	3.00	2.00	2.40	-	2.67	-	4.20	3.40	-	2.00	1.00	-	3.80	3.33	1.33	2.50	2.67	-	28.60
28P	3.50	-	-	5.00	5.00	-	4.00	-	5.00	5.00	-	2.25	1.50	1.50	4.50	3.75	1.50	4.50	-	-	36.70
36B	2.50	-	-	-	2.60	-	4.40	-	3.75	3.20	-	1.80	2.00	-	3.00	3.00	1.50	5.00	-	-	30.40
13M	2.00	-	-	2.50	-	2.50	3.25	-	2.40	2.60	-	2.25	1.40	2.00	3.00	3.00	1.00	4.00	3.00	-	24.00
11P	2.00	-	-	-	3.67	3.00	3.00	-	3.60	2.40	-	2.00	1.20	-	3.60	2.75	1.40	3.33	2.00	-	25.20
18Q	2.00	-	-	2.00	2.33	-	2.60	-	3.40	2.80	-	2.00	2.00	-	5.00	3.50	2.50	3.00	2.00	-	26.40
7P	2.33	-	-	2.40	2.00	-	2.75	-	4.00	2.00	-	2.00	1.60	-	2.50	2.60	1.00	3.33	2.50	-	21.30
20P	-	-	-	2.00	-	-	2.00	-	2.60	2.40	-	1.80	1.20	-	1.80	2.60	1.00	2.00	2.00	-	17.00
15P	1.00	-	-	-	-	-	-	-	3.00	2.80	-	1.25	1.20	-	2.60	3.20	1.00	2.00	3.67	-	18.40
21P	-	-	-	3.00	2.00	-	3.00	-	2.80	3.00	-	1.87	1.25	-	3.11	2.00	1.80	3.78	3.00	-	18.30

Table 5-b. Guatemalan corn collections, with No. of collections, altitude and mean knob number for each of the 15 races in each of three groups: typical, atypical and introgressions.

Race	Typical			Atypical			Introgressions			Plants with Ab-10	Total No. of Ab-10	Plants with B-Type	Total No. of B-Type
	No. of coll.	Mean Alt. ft.	Mean Knob No.	No. of coll.	Mean Alt. ft.	Mean Knob No.	No. of coll.	Mean Alt. ft.	Mean Knob No.				
Serrano	10	8670	4.9				3	7650	6.5	1	1		
San Marceño	8	7890	4.2										
Quicheño	5	7440	5.4				3	7233	6.0				
Negro (F)	5	7425	6.8										
Olotón	5	6760	5.6	2	5900	7.8	6	6012	9.1	3	4		
Nal-Tel Ocho	2	5900	11.5							4	4		
Olotillo	2	5050	12.5				1	1600	12.5	3	3	1	1
Nal-Tel	7	4957	11.2	1	3700	11.5	16	3162	12.4	15	17	9	21
Negro (C)	1	3450	13.5				2	4327	9.9	1	1		
Comiteco							6	4276	11.40	1	1	1	1
Tepecintle	6	2868	11.9	1	900	14.0	9	1967	12.40	8	9	5	7
Dzit-Bacal							5	3460	11.50	2	3	1	1
Salvadoreño	8	1538	12.1				4	1930	11.75	8	8	8	11
Flint-Dent	10	1290	11.5				4	3000	9.40	1	1		
Tuxpeño	2	775	11.5				4	1928	11.75	2	2		

Table 6-b. Mean knob numbers characteristic of Central American countries.

Country	Mean knob number	
Mexico (1930 collection)	9.23	9.39
Mexico (Section A)	9.56	
Guatemala	12.00	
El Salvador	11.96	
Honduras	12.70	
Nicaragua	12.37	
Costa Rica	11.31	
Panama	10.70	

Figure 1b. Diagram showing relationship between altitude of collection and mean chromosome knob number in Guatemalan corns.

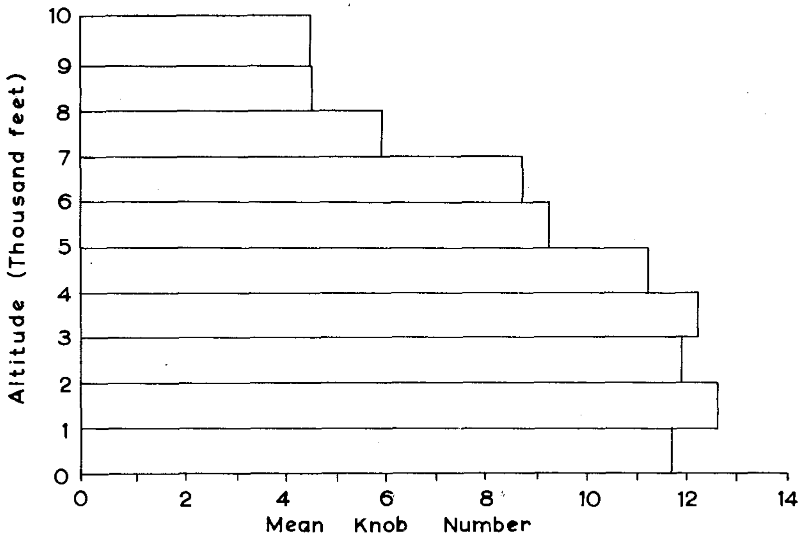


Figure 2b. Diagram showing the mean altitude for different maize race collections in Guatemala and their mean knob numbers.

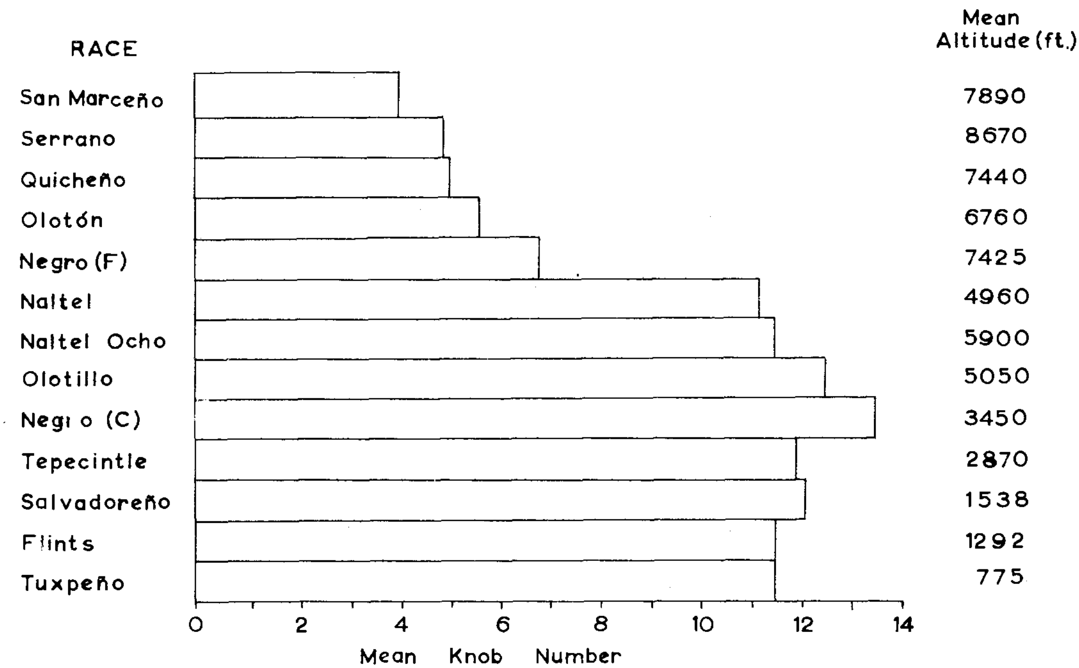


Figure 3b. Diagram showing the mean knob number and the knob number variation (mid-line) for corn collections of the Nal-tel race. Top, Nal-tel Guatemala; center, Nal-tel with introgressions; bottom, Nal-tel Yucatan, Mexico.

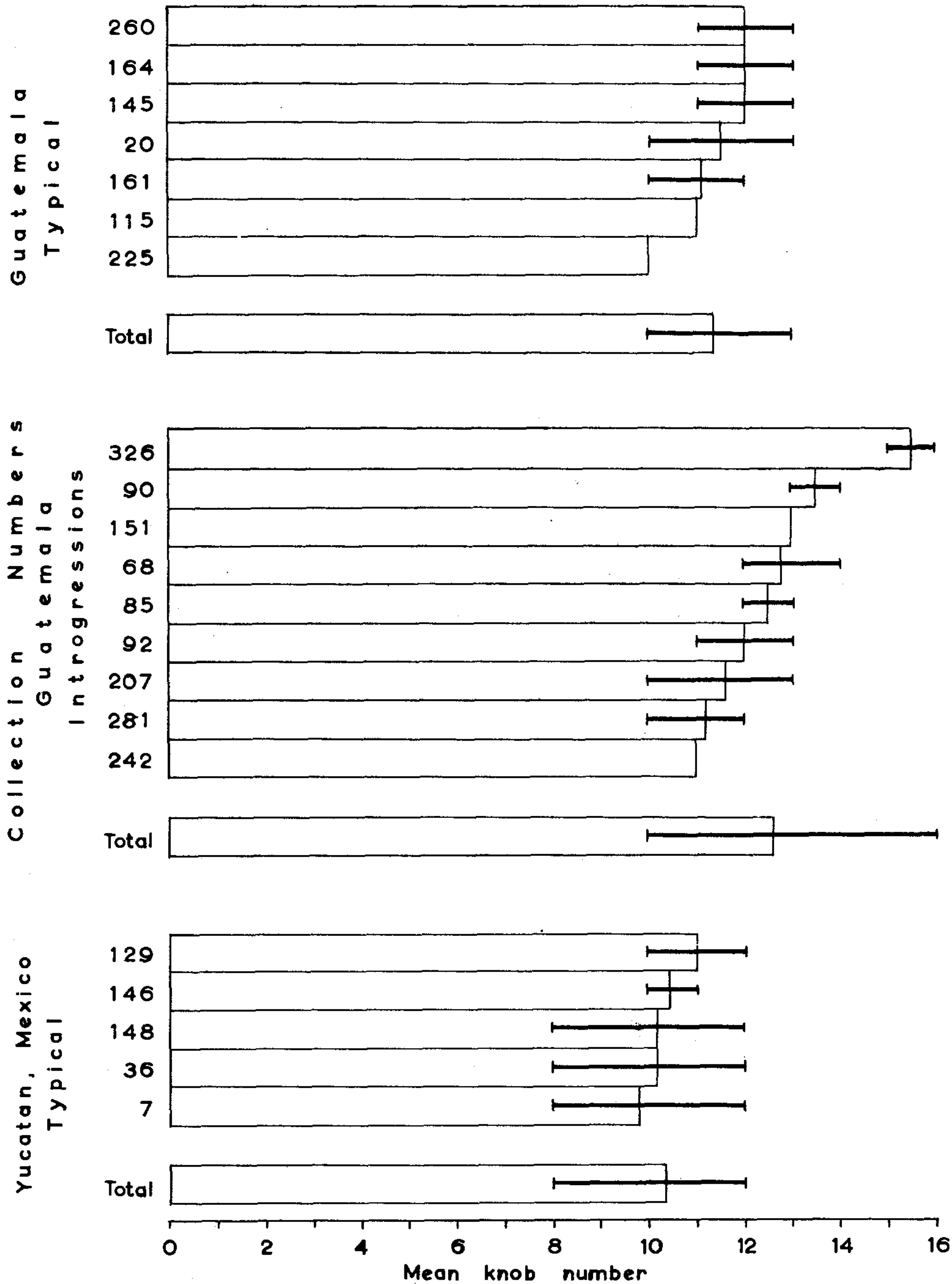


Figure 4b. Diagram showing mean knob number and the knob number variation (mid-line) for corn collections. Top, Nal-tel Ocho; bottom, Olotillo races.

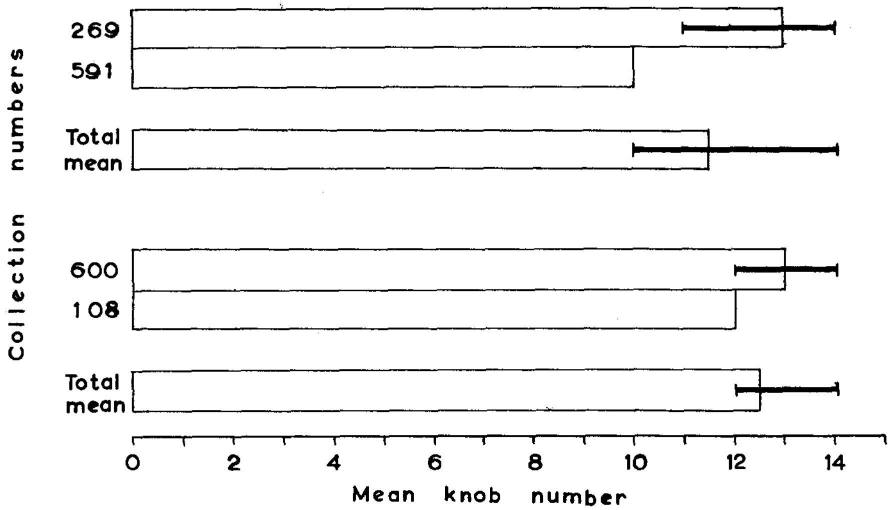


Figure 5b. Diagram showing mean knob number and the knob number variation (mid-line) for corn collections of the Negro de Chimaltenango race (highland and mid-highland).

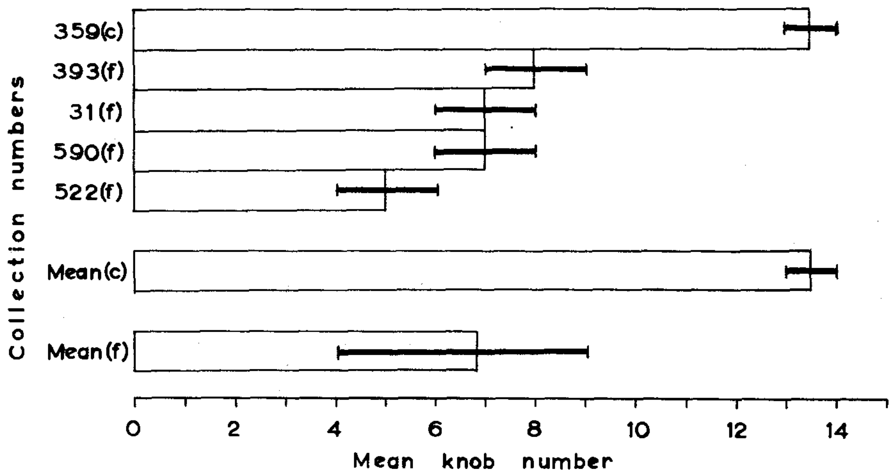


Figure 6b. Diagram showing mean knob number and the knob number variation (mid-line) for corn collections of the Dzit-Bacal race that showed introgressions.

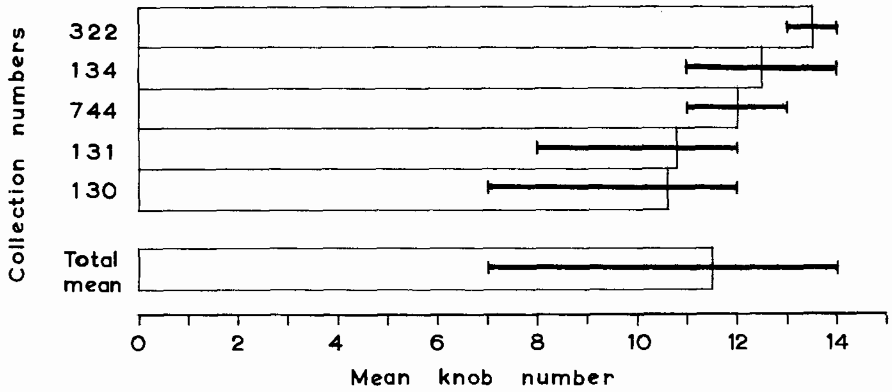


Figure 7b. Diagram showing mean knob number and the knob number variation (mid-line) for corn collections of the Comiteco race that showed introgressions.

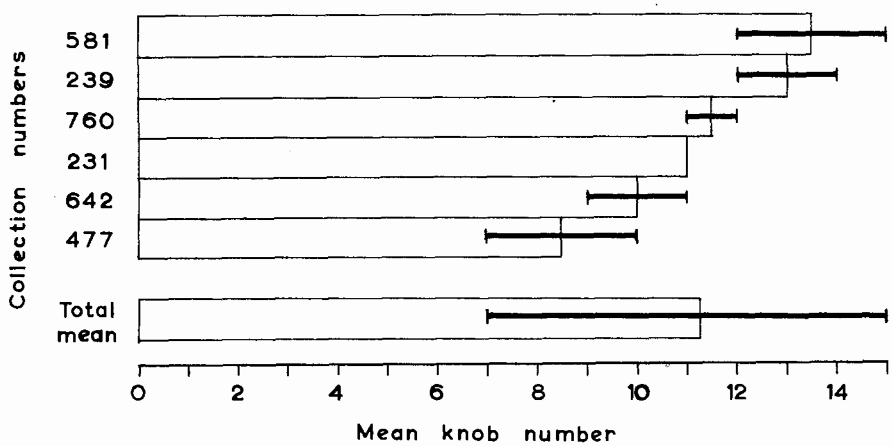


Figure 8b. Diagram showing mean knob number and the knob number variation (mid-line) for corn collections of the Tepecintle race.

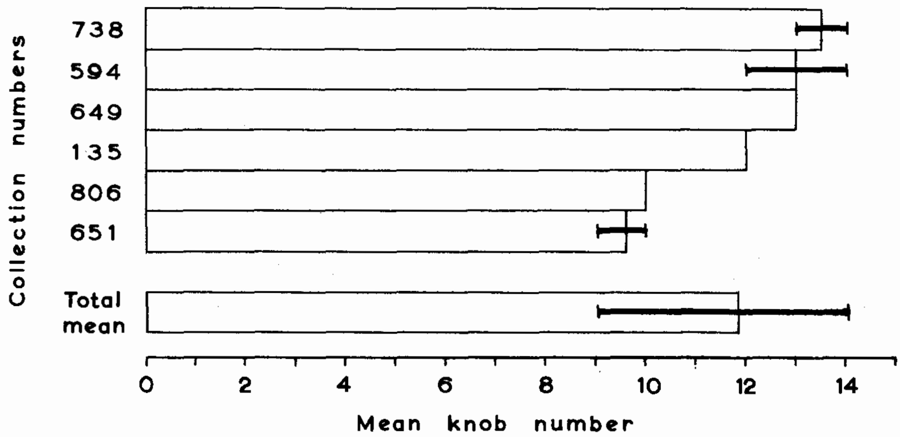


Figure 9b. Diagram showing mean knob number and the knob number variation (mid - line) for corn collections of typical and introgression types of the Tuxpeño race.

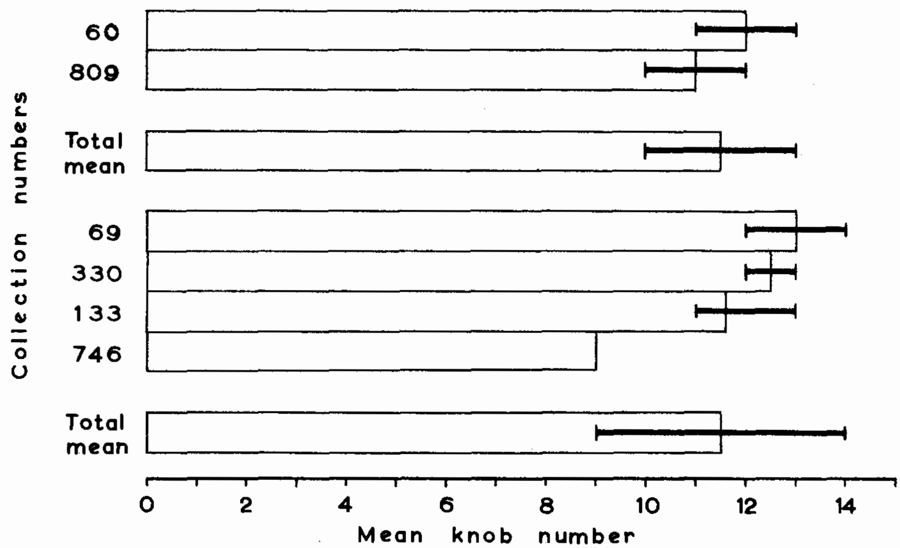


Figure 10b. Diagram showing mean knob number and the knob number variation (mid-line) for corn collections of the Salvadoreño race.

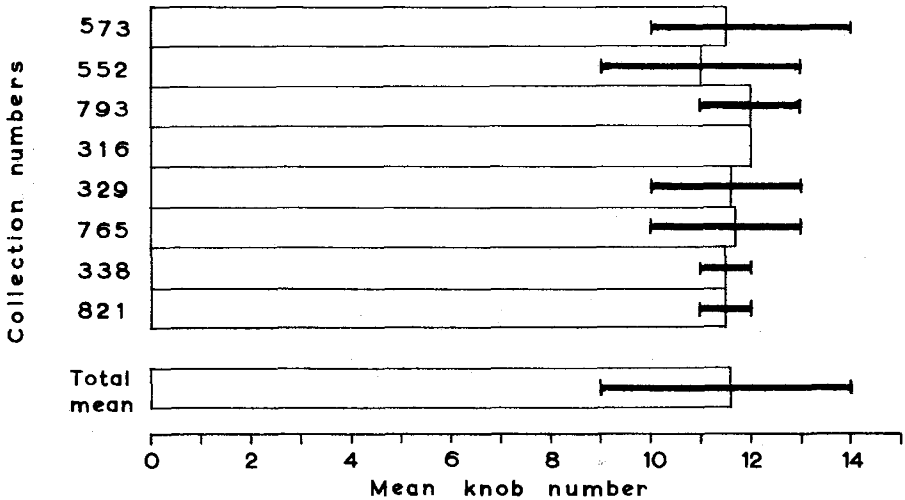


Figure 11b. Diagram showing mean knob number and the knob number variation (mid-line) for corn collections of the Dent-Flint-Flour complex including Coastal Tropical Flints and Cuban Flints.

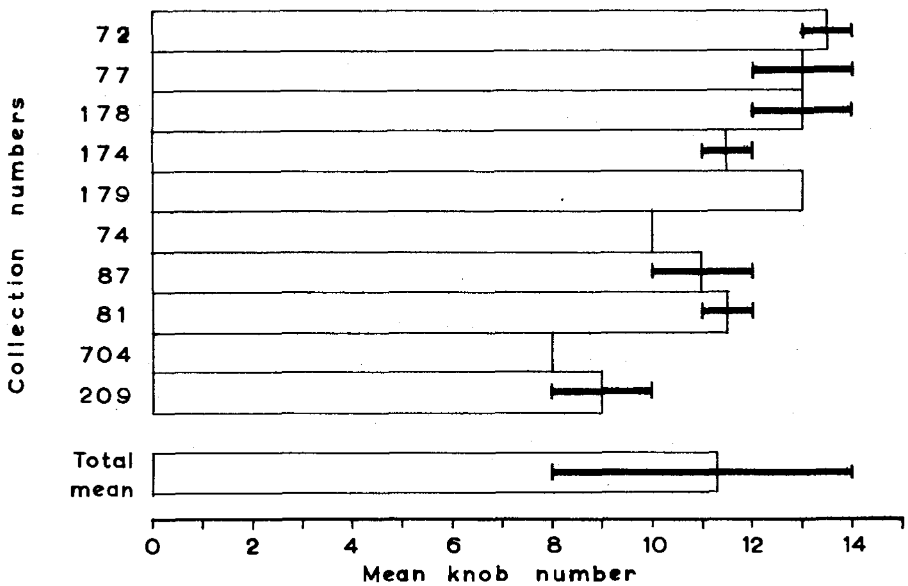


Figure 12 b. Diagram showing mean knob number and the knob number variation (mid-line) for corn collections of the Quicheño race.

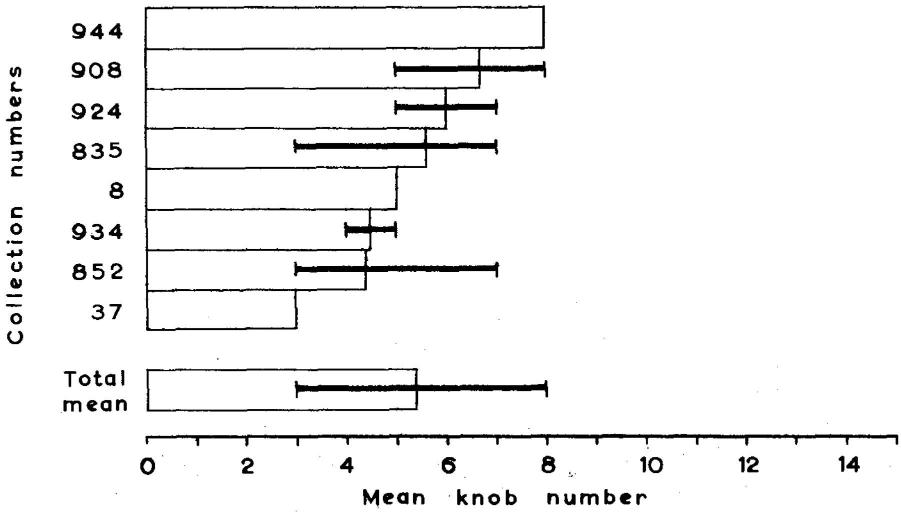


Figure 13 b. Diagram showing mean knob number and the knob number variation (mid-line) for corn collections of the Olotón race.

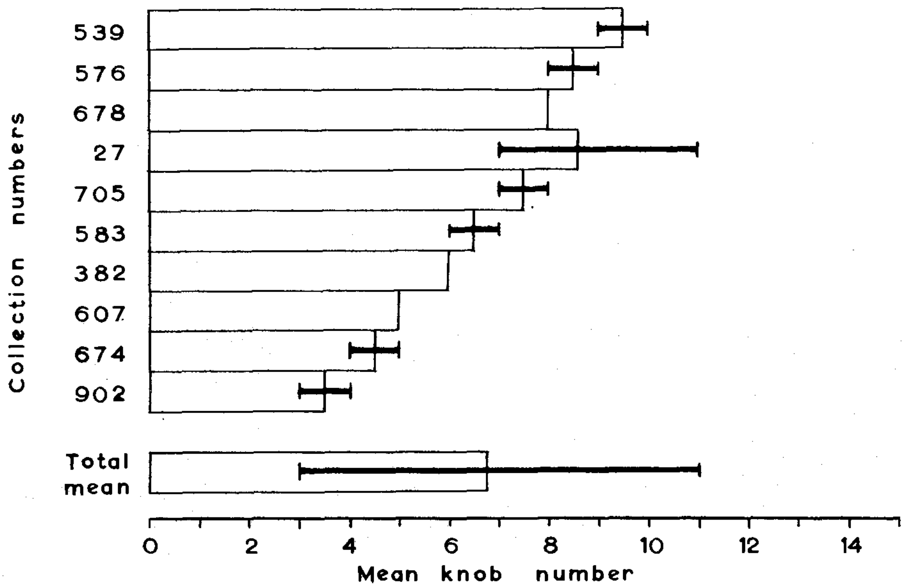


Figure 14b. Diagram showing mean knob number and the knob number variation (mid-line) for corn collections of the San Marceño race.

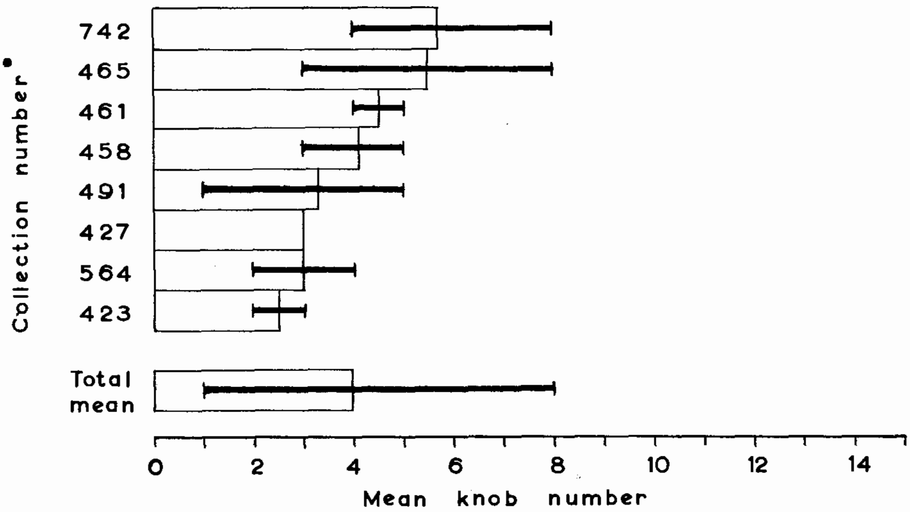


Figure 15b. Diagram showing mean knob number and the knob number variation (mid-line) for corn collections of the Serrano race.

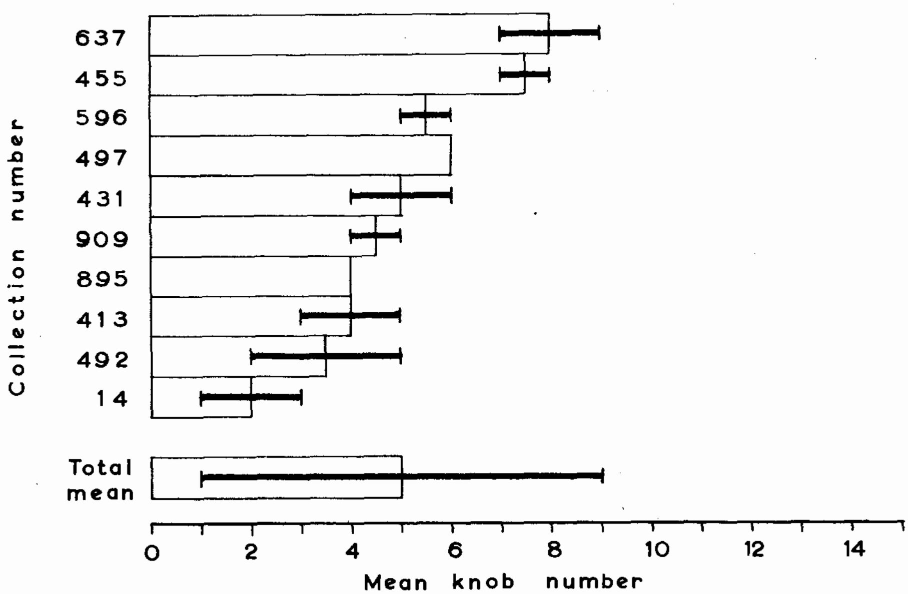


Figure 16b. Diagram showing mean knob number and the knob number variation (mid-line) for corn collections showing some Pira characteristics (Costa Rica and Panama).

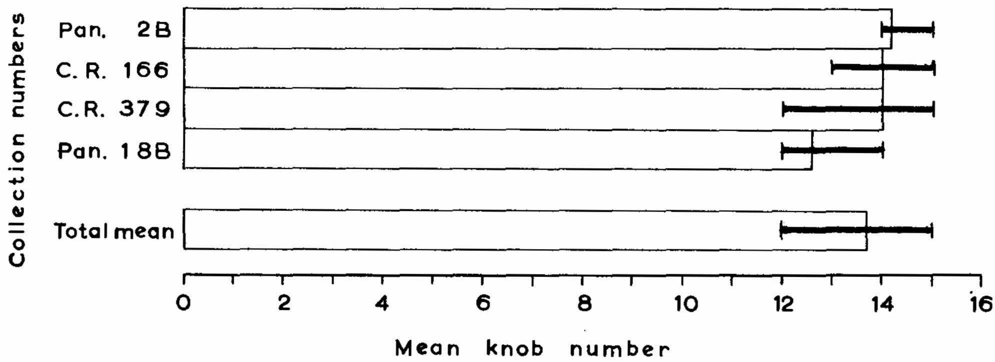


Figure 17b. Diagram showing mean knob number and the knob number variation (mid-line) for corn collections of the Maicena Flexible types (Costa Rica).

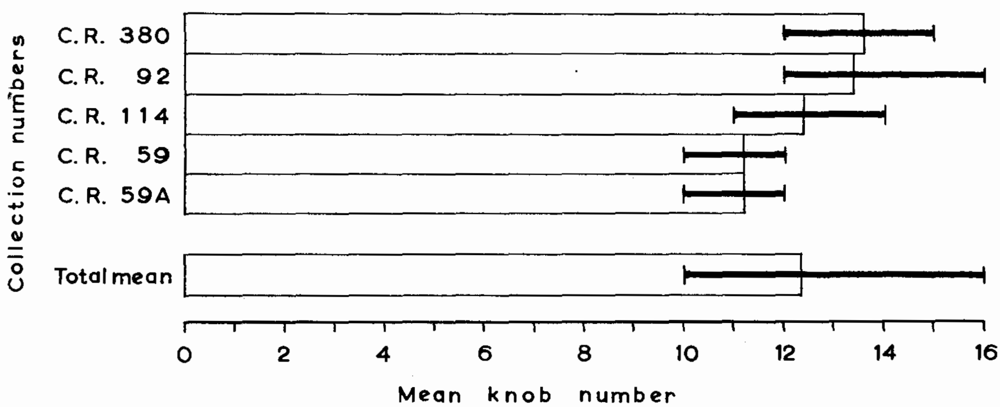


Figure 18b. Diagram showing mean knob number and the knob number variation (mid-line) for corn collections of the Flint type (Costa Rica).

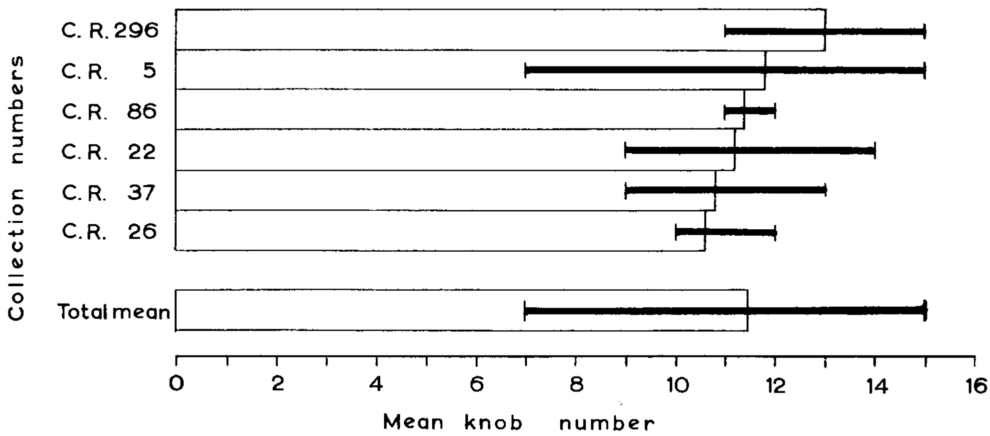


Figure 19b. Diagram showing mean knob number and the knob number variation (mid-line) for corn collections of the Amarillo Alajuela type (Costa Rica).

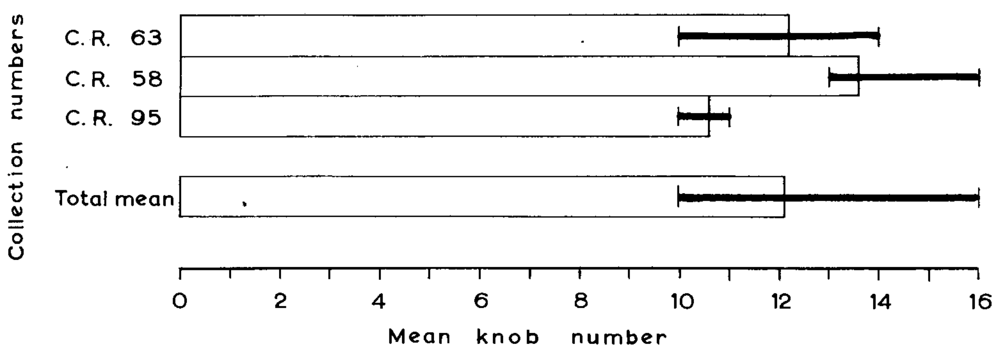


Figure 20b. Diagram showing mean knob number and the knob number variation (mid-line) for typical (top) and atypical (bottom) corn collections of the Coastal Tropical Flint race (Panama)

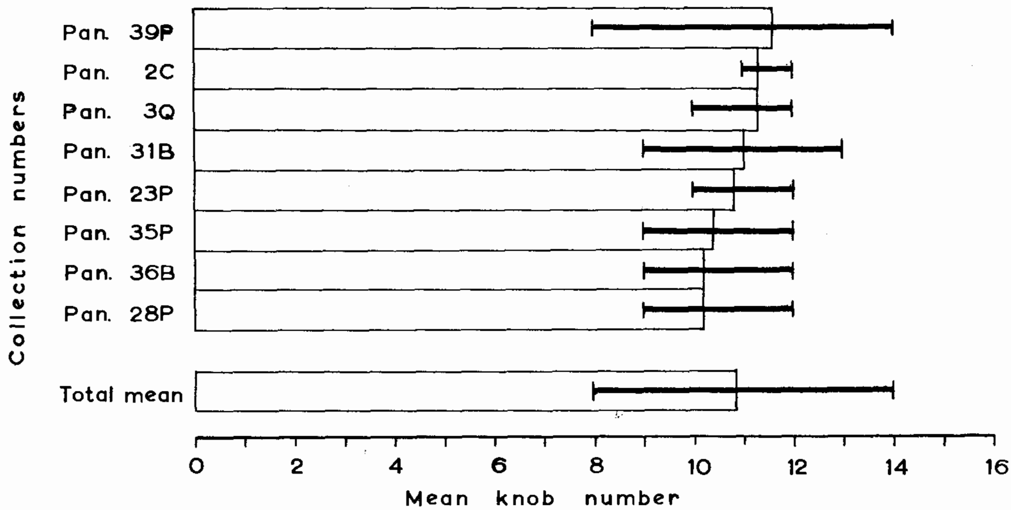


Figure 21b. Diagram showing mean knob number and the knob number variation (mid-line) for typical (top) and atypical (bottom) corn collections of the Amarillo Tico de Cartago race (Panama).

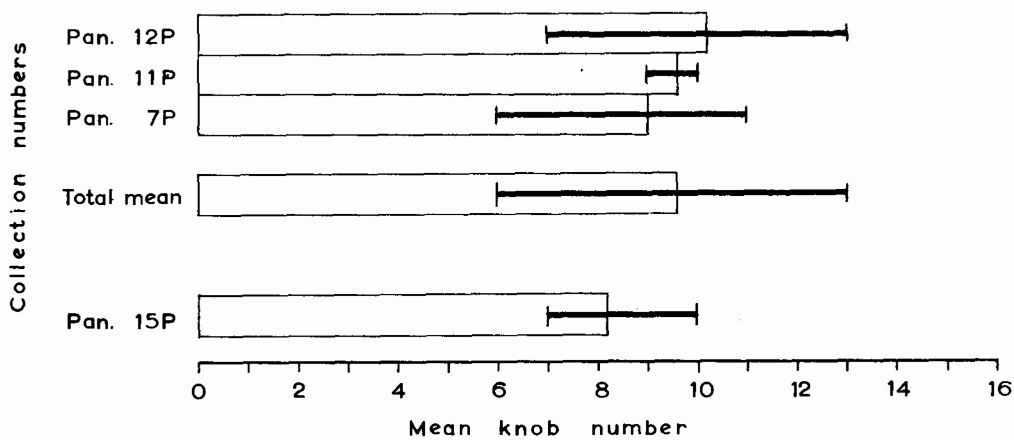


Figure 22b. Diagram showing mean knob number and the knob number variation (mid-line) for typical (top) and atypical (bottom) corn collections of the Montaña race (Costa Rica and Panama).

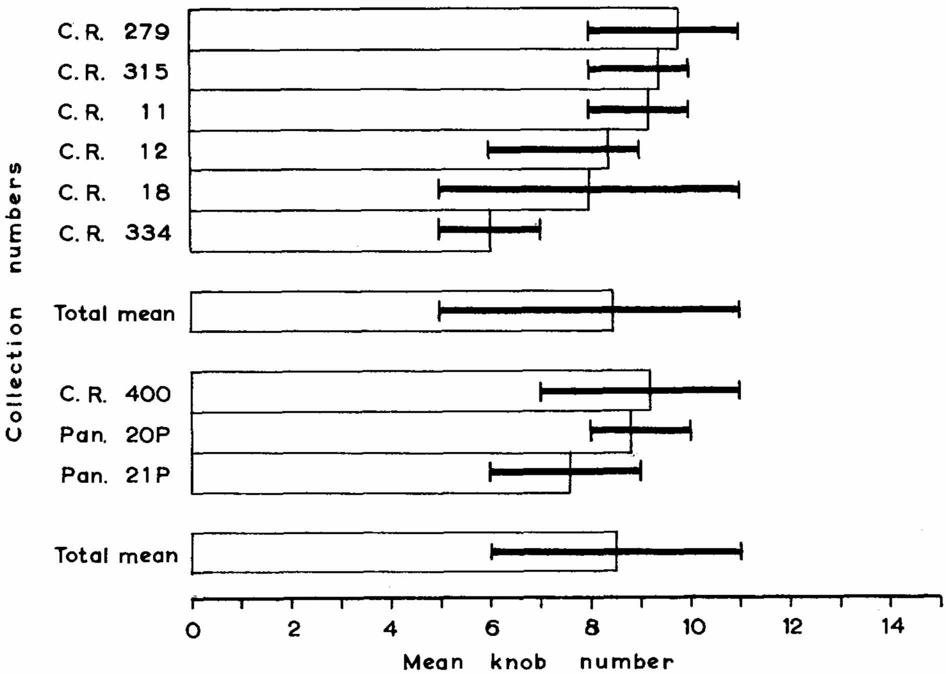
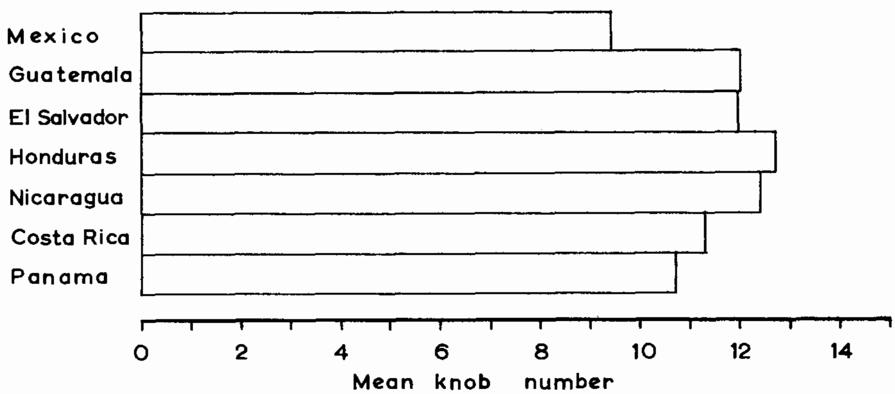


Figure 23b. Diagram showing mean chromosome knob numbers for the 7 Latin American countries of Central America.



S E C T I O N C

THE CHROMOSOMES OF CARIBBEAN CORNS

Albert E. Longley and Takeo A. Kato Y.

These studies of chromosome knobs and chromosome morphology include 75 or more collections from different Caribbean islands reaching from Trinidad in the southeast, to Cuba at the northwest corner of this sea. Both, Brown (2) and Hatheway (5) have acquainted us to the corns of these islands. Several races of corn are characteristically Caribbean, although frequently racial differences are not well defined.

Turning to Tables 1, 2c and 3c for data on collections from the Caribbean Islands, a summary was prepared and is given in Table 4c. The mean knob number for collections from each island are arranged in a high-low-high order, beginning at Trinidad and ending at Jamaica. This arrangement suggests that the more isolated islands have corns with the lowest knob numbers and that proximity to the continental main lands is responsible for the prevalence of higher knob numbers in corns found on such islands as Trinidad and Tobago in the southeast, and Jamaica and Cuba in the northwest (Figure 1c).

Beginning at the southeast, we find that the Trinidad collections all belong to the Tuson race and all have a characteristically high mean knob number and have a high total mean knob volume. These characteristic knob numbers of the Tuson corn race as found in Trinidad, are illustrated in Figure 2c. These figures serve to show a uniformity that seems to prevail in the corns of this island.

The knob complexes of corn from Trinidad and neighboring areas are characterized by the presence of some unusual large knobs. Such knobs are occasionally found in European and Asiatic corns and seem to offer some evidence that corns move eastward from this or neighboring areas.

Tobago corn collections are mostly of the Tuson race mixed with the Coastal Tropical Flint race. Representative chromosome knob complexes are shown diagramatically in the illustration of Figure 4c. In general, the knob number of corns from this island is high and the pattern found in this Tobago-Coastal Tropical Flint type of corn ties these collections rather closely to those from the island of Trinidad and the nearby South American mainland.

Except for one collection, the corns of Granada are Tuson in background, but show introgressions of the Coastal Tropical Flint race. There is a drop in mean knob number from that found in the two islands to the south, Tobago and Trinidad. This change in knob number is associated, possibly, with the increased distance from the mainland. One exceptional collection 9-D, is a pop type of corn and it has a reduced knob number and knob volume. (See Figure 3c and Tables 2c and 3c).

From Antigua, collections of Coastal Tropical Flint corns prevail. The knob number of this race is combined with other representatives of this Caribbean race in Figure 4c.

The Coastal Tropical Flint race is prevalent in other islands of the central Caribbean region. These collections are listed in Table 1. Those from the Barbados stand out in Figure 4c, because of their low knob number. The differences in knob number for this race may reflect the isolation of some collections on these small islands.

The collections from Guadalupe are either of the Coastal Tropical Flint race or are an atypical variety of this race. Their knob numbers are shown in Figure 4c.

St. Vincent provided two collections that are atypical variations of the Coastal Tropical Flint race. One collection from this island introduce the race Chandelle. This race is prevalent on the central Caribbean islands. Their knob numbers are shown in Figure 5c. This race and the atypical collections of it have, in some plants, chromosome knob numbers that are among the lowest found among the Caribbean corns.

The Barbados provided one exceptional collection (11 D). It is a Coastal Tropical Flint mixture and has a knob number high enough to suggest recent introgression with corns from the south. It is included with other flint-dent-flour types in Figure 9c. The Coastal Tropical Flint collections from the Barbados are shown in Figure 4c. They have lower knob number and are conspicuous among the other collections shown in this figure.

St. Croix provided one collection that is an atypical form of the Chandelle race, but it is included with illustrations of this race in Figure 5c. Two other collections from this island are typical of the St. Croix race. Their knob number is shown in Figure 6c. St. Croix is a typical Caribbean race, but several collections from adjacent islands, although placed in this race, are atypical and resemble the commercial corn Hickory King.

The one collection from the Virgin Islands is a Hickory King form of the St. Croix race. Its knob number is included in Figure 6c.

The St. Lucía collections have the low knob numbers characteristic of the more isolated areas of Central Caribbeans. They are listed in Table 1 as flint-dents, and the knob complex of one representative is shown in Figure 9c.

Puerto Rico collections have a mean knob number of 7.5. A number close to the mean for corns of the mid-Caribbean area. One collection is a characteristic Coastal Tropical Flint (5-D) and two are of the St. Croix race (17-D and 22-D). The remaining collections are shown among the Flint-Dent-Flour group of Figure 9c.

Two collections received early from Haiti have knob numbers among the lowest seen in Caribbean corns. Since they are dent types, the knob numbers are shown in Figure 9c. Several collections are representative of the Haitian Yellow race. The Haitian Yellow has its home in Haiti; 5 collections are typical of this race. The typical collections have low knob numbers, while the off-type collections have more knobs. The Haitian Yellow knob numbers are shown in Figure 7c.

The Dominican Republic provided corns of the Chandelle race and their knob numbers are given in Figure 5c. About an equal number of collections are more distinctly dented and have rather uniform knob complexes. The corns of the Dominican Republic have little in common with the corns from the Haitian side of the island, even the mean knob numbers are appreciably higher and more variable.

The Cuban Flint race is confined principally to Cuba, but there were only a few typical representatives of this race in the material available for study. The mean knob number of the Cuban Flint corns, as listed in Table 1, is above that found in the corns of the central Caribbean area. Figure 8c shows the upward trend in the chromosome knob number of this race. Off type Haitian Yellow and Chandelle collections also came from Cuba and their knob complexes are pictured in the illustrations of collections of these races from other islands in Figures 7c and 5c, respectively. Other Cuban collections are listed in Table 1 as dent-flint corns and the knob numbers of two representatives are shown in Figure 9c.

The Cuban corns have, in general, a mean knob number that places them in an intermediate position between the corns of the central Caribbean area and the corns in Mexico and other Central American countries.

The three collections from Jamaica are a step near, than the Cuban collections, both in knob numbers and volume towards the corns found on the nearest mainland, but they have retained the dent-flint complex that is found so frequently among the Caribbean collections. The knob number and knob number variation of a representative collection can be seen in Figure 9c.

A summary of the data on the chromosome knobs of corns from the Caribbean Islands is as follows:

1. Corn collections from points nearest the mainland, both at the north and south end of the arc made by the islands, have the highest knob number.

2. There is much to suggest that the higher knob number is due to contacts with the nearby mainland corns.

3. The corn collections with the lowest knob numbers came from the more isolated areas of the islands, particularly from small islands in the center in the arc formed by the islands.

4. Typical corn races were poorly represented in the collections studied and atypical material was prevalent.

5. The history of Caribbean corns seems to be reflected in their chromosome knob pattern. Isolation seems to have had an effect on knob number and size, similar to the effect on corns from isolated areas of Guatemala.

Table 2c.- Data showing, for the various maize collections of the Caribbean Islands, the number of chromosome knobs at the 20 knob-forming positions. Collections from each island are arranged in a descending order for the number of knobs present.

Collection No. and Country	Mean Knob No.	No. of Plants	Number of knobs at the 20 knob forming positions																					Plants with ab 10	Total No. ab 10	Plants with BT	Total No. BT
			1S a	1S b	1L	2S	2L	3S	3L	4S	4L	5L	6S	6L a	6L b	6L c	7S	7L	8L a	8L b	9S	9L	10L				
Jamaica																											
1	12.0	1	-	-	-	-	1	-	1	-	1	1	X	-	1	1	1	1	1	1	1	1	-	-	-	-	-
5J	11.5	2	1	-	-	-	2	-	2	-	2	2	X	-	2	2	2	2	2	1	2	1	-	-	-	1	2
1J	10.5	2	-	-	-	-	2	-	1	-	2	2	X	-	2	2	1	2	2	2	1	-	-	-	-	-	-
Cuba																											
23J	12.0	4	2	-	-	1	4	-	4	-	4	4	X	-	4	4	2	4	4	4	4	3	-	-	-	-	-
25J	11.4	5	3	-	-	-	5	-	5	-	5	5	X	1	5	5	3	5	5	5	4	1	-	-	-	-	-
19J	11.0	5	1	-	-	-	5	-	4	-	5	5	X	-	5	5	3	5	5	5	4	3	-	-	-	-	-
11	10.6	5	-	-	-	-	5	-	5	-	5	5	X	-	5	4	5	5	5	4	5	-	-	-	-	5	6
9	10.4	5	1	-	-	-	5	-	4	-	5	5	X	-	5	4	4	5	3	4	3	4	-	1	1	-	-
17	10.4	5	3	1	-	-	5	-	3	-	4	5	X	-	5	4	4	5	5	4	-	4	-	1	1	-	-
43	10.4	5	-	-	-	-	5	-	3	-	5	5	X	-	5	5	-	5	5	5	5	4	-	-	-	-	-
1J	10.4	5	3	-	-	-	5	-	3	-	5	5	X	-	5	5	-	5	5	5	5	1	-	1	1	-	-
67	10.2	5	4	1	-	-	5	-	4	-	5	5	X	-	4	5	1	5	5	-	5	2	-	-	-	-	-
16J	10.2	5	1	-	-	-	5	-	5	-	5	5	X	-	4	5	1	5	5	3	5	2	-	1	1	-	-
20J	10.2	5	1	-	-	-	5	-	5	-	5	5	X	-	5	4	-	5	5	3	5	2	-	-	-	-	-
22J	10.2	5	2	1	-	1	4	-	5	-	5	5	X	-	5	2	2	5	5	4	5	-	-	-	-	-	-
7	10.0	5	2	-	-	-	5	-	5	-	5	5	X	-	4	4	-	5	5	5	5	-	-	-	-	-	-
28	10.0	5	3	2	-	-	4	-	5	-	5	5	X	-	5	1	3	5	5	2	5	-	-	1	1	-	-
29	10.0	5	2	1	-	-	5	-	5	-	5	5	X	-	5	2	1	5	5	4	5	-	-	-	-	-	-
15J	10.0	5	2	-	-	-	5	-	4	-	5	5	X	-	3	4	1	5	5	5	5	1	-	-	-	-	-
5J	9.8	5	3	-	-	-	5	-	4	-	4	5	X	-	4	4	1	5	5	4	5	-	-	1	1	-	-
7J	9.8	5	2	-	-	-	5	-	3	-	5	5	X	-	5	2	1	5	5	5	5	1	-	-	-	-	-
24J	9.4	5	2	-	-	-	5	-	4	-	5	5	X	-	4	3	1	5	5	3	4	1	-	-	-	-	-
2J	9.2	5	-	-	-	-	5	-	1	-	5	5	X	-	5	5	1	5	5	4	5	-	-	-	-	-	-
3J	9.2	5	-	-	-	-	4	-	3	-	5	5	X	-	4	4	1	5	5	5	4	1	-	-	-	-	-
11J	8.8	5	1	-	-	-	5	-	3	-	5	5	X	-	2	5	2	5	5	5	1	-	-	-	-	-	-
20	8.4	5	-	-	-	-	5	-	5	-	3	4	X	-	5	5	-	5	5	-	5	-	-	-	-	4	7
Dominican Rep.																											
50D	10.6	5	1	-	-	-	5	1	4	-	5	5	X	-	4	5	4	5	4	5	3	2	-	4	4	-	-
66D	10.6	5	2	-	-	-	4	-	5	-	5	5	X	-	5	5	-	5	5	5	5	2	-	1	1	1	2
6D	10.2	5	2	-	1	-	4	-	4	-	5	5	X	-	5	5	-	5	5	5	1	4	-	2	2	2	2
22D	9.8	5	1	-	-	-	1	-	5	-	5	5	X	-	5	5	-	5	5	5	3	4	-	2	2	1	2

Collection No. and Country	Mean Knob No.	No. of Plants	1S a	1S b	1L	2S	2L	3S	3L	4S	4L	5L	6S	6L a	6L b	6L c	7S	7L	8L a	8L b	9S	9L	10L	Plants with ab 10	Total No. ab 10	Plants with BT	Total No. BT
			Number of knobs at the 20 knob forming positions																								
Dominican Republic																											
25D	9.4	5	-	-	-	-	4	-	5	-	5	5	X	-	4	5	-	5	5	4	3	2	-	-	-	1	1
29D	9.4	5	1	-	-	-	5	-	3	-	5	5	X	-	5	4	-	5	5	5	4	-	-	-	-	-	-
13D	9.2	5	-	-	-	-	4	-	3	-	5	5	X	1	5	5	-	4	4	5	-	5	-	2	2	-	-
63D	9.0	5	1	-	-	-	5	-	3	-	5	5	X	-	5	4	-	4	5	5	1	2	-	-	-	5	9
36D	8.8	5	-	-	-	-	4	-	4	-	5	5	X	-	5	5	-	5	4	5	1	1	-	-	-	-	-
60D	8.5	4	-	-	-	-	4	-	1	-	4	4	X	-	4	4	-	4	2	4	2	1	-	-	-	-	-
1D	7.4	5	-	-	-	-	2	-	4	-	4	5	X	-	4	5	-	5	4	1	1	2	-	-	-	-	-
Haiti																											
14J	11.0	2	1	-	-	-	2	-	2	-	2	2	X	-	2	2	-	2	2	2	2	1	-	-	-	-	-
27J	10.5	2	1	1	-	-	2	-	2	-	2	2	X	-	2	1	2	2	2	-	1	1	-	-	-	-	-
13J	9.5	2	1	-	-	-	1	-	1	-	2	2	X	-	2	1	-	2	2	2	1	2	-	1	1	-	-
17J	8.5	2	2	-	-	-	2	-	1	-	2	2	X	-	2	2	-	2	1	1	-	-	-	-	-	-	-
20J	8.5	2	-	-	-	-	1	-	1	-	1	2	X	-	1	2	-	2	2	1	2	2	-	-	-	-	-
1J	7.5	2	2	-	-	-	-	-	-	-	2	2	2La	-	2	2	-	2	2	1	-	-	-	-	-	-	-
22J	7.5	2	-	-	-	-	1	-	2	-	1	2	X	-	2	1	-	2	2	-	1	1	-	-	-	-	-
2J	7.0	3	1	-	-	-	1	-	-	-	3	3	X	-	3	2	-	3	-	2	1	2	-	-	-	-	-
2	6.5	2	1	-	-	-	1	-	-	-	2	2	1La	-	2	2	-	2	1	-	-	-	-	-	-	-	-
10J	6.5	2	1	-	-	-	-	-	-	-	2	2	X	-	2	1	-	2	2	1	-	-	-	-	-	-	-
23J	6.0	2	-	-	-	-	1	-	-	-	2	2	X	-	2	1	-	2	-	2	-	-	-	-	-	-	-
24J	6.0	2	-	-	-	-	2	-	-	-	1	2	X	-	-	1	-	1	2	-	2	1	-	-	-	-	-
7	5.5	2	1	-	-	-	-	-	-	-	2	2	X	-	-	1	-	2	2	1	-	-	-	-	-	-	-
Puerto Rico																											
15D	9.5	2	-	-	-	-	2	-	1	-	2	2	X	-	2	2	-	2	2	2	2	-	-	-	-	-	-
1D	8.0	2	-	-	-	-	2	-	1	-	2	2	X	-	2	2	-	2	2	1	-	-	-	-	-	-	-
3D	8.0	2	1	-	-	-	2	-	-	-	2	2	X	-	2	2	-	2	2	1	-	-	-	1	1	-	-
5D	8.0	2	-	-	-	-	2	-	2	-	2	2	X	-	1	2	-	2	2	1	-	-	-	1	1	-	-
14D	8.0	2	-	-	-	-	2	-	-	-	2	2	X	-	2	2	-	2	2	-	2	-	-	-	-	-	-
22D	8.0	2	-	-	-	-	2	-	1	-	2	2	X	1	2	1	-	2	2	1	-	-	-	-	-	-	-
20D	7.5	2	-	-	-	-	2	-	1	-	2	2	X	-	1	2	-	2	2	1	-	-	-	-	-	-	-
17D	7.0	2	-	-	-	-	2	-	-	-	2	2	X	-	2	1	-	2	2	-	1	-	-	-	-	-	-
8D	6.5	2	-	-	-	-	2	-	1	-	2	2	X	-	-	2	-	2	2	-	-	-	-	1	1	-	-
11D	6.0	2	-	-	-	-	2	-	-	-	2	2	1La	-	-	2	-	2	2	-	-	-	-	1	1	-	-
21D	6.0	1	-	-	-	-	-	-	-	-	1	1	X	-	-	1	-	1	1	1	-	-	-	-	-	-	-
12D	5.5	2	-	-	-	-	-	-	-	-	2	2	X	-	1	2	-	2	2	-	-	-	-	-	-	-	-
Virgin Islands																											
4	7.0	4	1	-	-	-	4	-	3	-	4	4	4La	-	1	-	1	4	4	2	-	-	-	4	5	-	-
St. Lucia																											
4D	8.0	2	-	-	-	-	2	-	2	-	2	2	X	-	2	2	-	2	2	-	-	-	-	-	-	-	-
2D	7.0	2	-	-	-	-	2	-	-	-	2	2	X	-	2	2	-	2	1	1	-	-	-	-	-	-	-
St. Croix																											
6D	9.6	5	-	-	-	-	5	-	5	-	5	5	X	1	3	3	4	5	5	4	2	1	-	-	-	-	-
4D	7.2	5	-	-	-	-	5	-	-	-	5	5	X	-	5	5	-	5	3	3	-	-	-	-	-	-	-
5D	7.0	5	-	1	-	-	3	-	2	-	5	5	X	-	2	3	-	4	5	5	-	-	-	-	-	-	-

Collection No. and Country	Mean Knob No.	No. of Plants	1S a	1S b	1L	2S	2L	3S	3L	4S	4L	5L	6S	6L a	6L b	6L c	7S	7L	8L a	8L b	9S	9L	10L	Plants with ab 10	Total No. ab 10	Plants with BT	Total No. BT
			Number of knobs at the 20 knob forming positions																								
Barbados																											
11D	12.0	5	3	-	-	-	5	-	4	-	5	5	X	-	5	5	4	5	5	5	5	5	-	-	-	-	-
10D	7.2	5	-	-	-	-	2	-	2	-	5	4	X	-	2	5	1	5	2	3	-	5	-	-	-	-	-
2D	6.8	5	-	-	-	-	3	-	2	-	5	4	X	-	1	4	1	5	5	-	-	4	-	-	-	-	-
St. Vincent																											
1D	11.5	2	2	-	-	-	2	-	2	-	2	2	1La	-	2	2	1	2	2	2	-	1	-	-	-	1	1
3D	10.5	2	2	-	-	-	1	-	2	-	2	2	X	-	2	1	-	2	2	2	1	2	-	-	-	-	-
8D	9.0	2	-	-	-	-	2	-	1	-	2	2	X	-	-	2	1	2	2	2	2	-	-	-	-	-	-
6D	8.0	2	-	-	-	-	2	-	1	-	2	2	1La	-	2	2	-	2	1	1	1	-	-	-	-	-	-
10D	8.0	2	1	-	-	-	2	-	1	-	2	2	X	-	2	2	-	2	1	-	-	1	-	-	-	-	-
Guadalupe																											
3D	11.8	5	4	1	-	1	4	-	5	-	5	5	X	1	5	4	2	5	5	4	5	4	-	2	2	-	-
4D	11.0	1	-	1	-	-	1	-	1	-	1	1	X	-	1	1	-	1	1	-	1	1	-	-	-	-	-
7D	10.2	5	4	-	-	-	3	-	2	-	5	5	X	-	5	3	1	5	4	5	5	4	-	-	-	-	-
8D	10.0	4	-	-	-	-	4	-	4	-	3	4	X	1	4	4	-	4	3	3	2	4	-	-	-	-	-
12D	8.6	5	3	-	-	-	5	-	5	-	2	5	X	-	5	1	-	5	5	4	2	1	-	-	-	-	-
10D	8.3	3	-	-	-	-	3	-	2	-	2	3	X	1	2	2	1	3	2	2	1	1	-	-	-	-	-
5D	7.6	5	1	1	-	-	1	-	2	-	4	5	X	-	4	4	1	5	4	4	-	2	-	-	-	-	-
Martinica																											
1D	10.0	2	-	-	-	-	2	-	1	-	2	2	X	-	2	2	-	2	2	1	2	2	-	-	-	-	-
Antigua																											
6D	11.0	5	1	-	-	-	4	-	4	-	5	5	X	1	5	5	4	5	5	5	5	1	-	-	-	-	-
3D	10.8	5	2	-	1	-	4	-	1	-	5	5	X	1	4	5	5	5	5	5	5	1	-	-	-	-	-
4D	10.4	5	-	-	-	-	5	-	1	-	5	5	X	2	5	5	4	5	5	3	5	2	-	-	-	-	-
Granada																											
17D	12.5	2	2	-	-	-	2	-	2	-	2	2	X	-	2	2	-	2	2	2	2	2	-	-	-	-	-
11D	12.3	3	3	-	-	-	3	-	3	-	-	3	X	2	3	3	1	3	3	2	3	3	-	-	-	-	-
7D	12.0	4	4	-	-	-	4	-	4	-	2	4	X	1	4	4	2	4	4	4	4	3	-	-	-	-	-
1D	11.5	4	4	-	-	-	4	-	4	-	2	4	X	1	4	4	-	4	4	4	3	4	-	1	2	-	-
13D	11.0	2	2	-	-	-	2	-	2	-	-	2	X	-	2	2	1	2	2	2	2	1	-	-	-	-	-
16D	10.0	3	2	-	-	-	3	-	2	-	2	3	X	-	2	3	-	3	3	3	2	2	-	-	-	-	-
9D	9.0	2	2	-	-	-	2	-	2	-	-	2	1La	-	2	2	-	2	1	1	2	1	-	-	-	-	-
Tobago																											
6D	12.5	2	2	-	-	-	2	-	2	-	2	2	X	-	2	2	2	2	2	1	2	2	-	1	1	-	-
10D	12.3	3	1	-	-	-	3	-	3	-	3	3	X	-	3	3	3	3	3	3	3	3	-	-	-	-	-
4D	12.0	2	1	-	-	-	2	-	2	-	2	2	X	-	2	2	2	2	2	1	2	2	-	-	-	-	-
17D	12.0	2	2	-	-	-	2	-	2	-	2	2	X	-	2	2	2	2	2	2	1	-	-	-	-	-	-
2D	11.5	2	2	-	-	-	2	-	2	-	2	2	X	-	2	2	2	2	2	-	1	2	-	-	-	-	-

Collection No. and Country	Mean Knob No.	No. of Plants	1S a	1S b	1L	2S	2L	3S	3L	4S	4L	5L	6S	6L a	6L b	6L c	7S	7L	8L a	8L b	9S	9L	10L	Plants with ab 10	Total No. ab 10	Plants with BT	Total No. BT
			Number of knobs at the 20 knob forming positions																								
Trinidad																											
16D	13.3	3	3	-	-	2	3	-	3	-	3	3	X	-	3	3	2	3	3	3	3	3	-	-	-	-	-
8D	13.0	2	2	-	-	-	2	-	2	-	2	2	X	-	2	2	2	2	2	2	2	2	-	-	-	-	-
13D	13.0	2	2	-	-	-	2	-	2	-	2	2	X	-	2	2	2	2	2	2	2	2	-	-	-	-	-
2D	12.5	2	2	-	-	-	2	-	2	-	2	2	X	-	2	1	2	2	2	2	2	2	-	-	-	-	-
31D	12.5	2	2	-	-	-	2	-	2	-	2	2	X	-	2	2	1	2	2	2	2	2	-	1	1	-	-
33D	12.5	2	2	-	-	-	2	-	2	-	2	2	X	-	2	2	1	2	2	2	2	2	-	1	1	-	-
4D	12.0	2	2	-	-	-	2	-	2	-	2	2	X	-	2	2	1	2	2	1	2	2	-	-	-	-	-
6D	12.0	2	2	-	-	-	2	-	2	-	2	2	X	-	2	2	-	2	2	2	2	2	-	-	-	-	-
35D	12.0	2	1	-	-	-	2	-	2	-	2	2	X	-	2	2	2	2	2	2	1	2	-	-	-	-	-
1D	11.0	2	2	-	-	-	2	-	2	-	2	2	X	-	2	1	2	2	2	1	1	1	-	-	-	-	-

Table 3c.- Data from the various maize collections from the Caribbean Islands, arranged in the order shown in Table 2c and showing mean knob volumes, 0-5 at each of the 20 knob forming positions.

Collection No. and Country	The mean volume of knobs at 20 knob-forming positions																				Mean Knob Volume
	1S a	1S b	1L	2S	2L	3S	3L	4S	4L	5L	6L a	6L b	6L c	7S	7L	8L a	8L b	9S	9L	10L	
Jamaica																					
1	-	-	-	-	5.00	-	3.00	-	3.00	3.00	-	2.00	2.00	5.00	2.00	3.00	1.00	2.00	5.00	-	36.00
5J	2.00	-	-	-	3.50	-	3.00	-	3.00	2.50	-	2.50	2.00	3.50	2.50	3.00	1.00	4.00	2.00	-	32.00
1J	2.00	-	-	-	5.00	-	4.00	-	3.00	2.50	-	2.50	1.50	4.00	5.00	3.00	1.00	5.00	-	-	32.00
Cuba																					
23J	2.00	-	-	2.00	2.50	-	2.50	-	2.50	2.00	-	1.50	1.25	2.00	2.25	2.25	1.00	2.75	1.75	-	24.75
25J	2.00	-	-	-	3.00	-	3.00	-	3.00	2.80	2.00	2.00	1.20	1.66	2.60	2.40	1.00	3.25	2.00	-	26.60
19J	1.00	-	-	-	2.60	-	3.00	-	2.80	3.00	-	1.80	1.40	1.66	2.80	2.20	1.00	2.75	2.66	-	25.20
11	-	-	-	-	2.80	-	3.00	-	2.80	2.60	-	1.60	1.25	2.00	3.00	3.00	1.00	3.20	-	-	25.80
9	1.00	-	-	-	2.60	-	3.00	-	3.20	2.80	-	1.40	1.00	2.00	2.00	2.33	1.00	2.67	2.50	-	22.00
17	2.00	1.00	-	-	3.00	-	2.66	-	2.75	1.80	-	1.60	1.25	2.25	2.40	2.80	1.00	-	2.50	-	22.40
43	-	-	-	-	3.00	-	2.00	-	2.40	2.40	-	1.40	1.40	-	2.20	2.60	1.00	2.80	2.25	-	22.20
1J	2.00	-	-	-	3.00	-	2.67	-	3.20	2.40	-	2.00	1.60	-	3.20	3.20	1.00	2.80	2.00	-	25.60
67	2.00	1.00	-	-	3.80	-	2.50	-	3.00	3.00	-	1.00	1.60	2.00	2.80	3.00	-	2.00	2.50	-	24.80
16J	2.00	-	-	-	2.80	-	2.60	-	2.60	2.40	-	2.00	1.80	2.00	2.00	2.80	1.00	2.60	1.00	-	23.00
20J	2.00	-	-	-	2.40	-	2.60	-	2.80	2.60	-	1.80	1.00	-	3.00	2.60	1.00	3.40	2.50	-	24.40
22J	2.50	1.00	-	2.00	2.50	-	2.60	-	2.60	2.60	-	1.60	1.00	2.00	2.60	2.40	1.00	3.40	-	-	23.20
7	2.00	-	-	-	3.20	-	2.20	-	3.20	2.80	-	1.25	1.25	-	2.80	2.60	1.00	3.80	-	-	24.20
28	1.33	1.50	-	-	2.50	-	2.60	-	2.60	2.20	-	1.80	1.00	2.00	2.20	2.80	1.00	3.60	-	-	23.40
29	2.00	1.00	-	-	3.20	-	3.00	-	3.00	3.00	-	2.00	1.50	2.00	3.00	3.00	1.00	3.00	-	-	26.00
15J	2.00	-	-	-	3.00	-	2.75	-	2.60	3.00	-	2.00	1.50	2.00	2.00	2.20	1.00	3.60	2.00	-	24.80
5J	2.00	-	-	-	2.80	-	2.75	-	2.75	2.80	-	2.00	1.25	2.00	2.60	2.80	1.00	2.60	-	-	22.20
7J	2.00	-	-	-	2.60	-	2.66	-	2.80	2.20	-	2.00	1.00	2.00	2.00	2.60	1.00	1.60	-	-	20.40
24J	1.50	-	-	-	2.60	-	2.25	-	2.80	2.60	-	2.00	1.33	2.00	2.00	2.60	1.00	2.75	2.00	-	19.80
2J	-	-	-	-	3.20	-	2.00	-	3.00	2.80	-	1.60	1.00	1.00	1.80	2.60	1.00	1.80	-	-	19.00
3J	-	-	-	-	3.00	-	3.00	-	2.80	2.60	-	1.50	1.00	2.00	3.20	3.00	1.00	2.50	2.00	-	21.00
11J	2.00	-	-	-	2.40	-	2.66	-	2.80	2.40	-	2.00	1.40	2.00	2.20	2.60	1.00	2.00	-	-	18.80
20	-	-	-	-	4.40	-	4.60	-	5.00	3.75	-	2.00	1.20	-	4.80	4.20	-	5.00	-	-	32.20
Dominican Republic																					
50D	2.00	-	-	-	3.00	2.00	2.50	-	3.60	3.20	-	1.75	1.40	2.00	3.20	2.25	1.00	2.00	2.50	-	25.80
66D	2.00	-	-	-	2.75	-	3.60	-	3.40	2.80	-	1.20	1.40	-	3.00	2.80	1.00	3.20	2.50	-	26.40
6D	2.00	-	1.00	-	4.00	-	3.00	-	3.80	2.80	-	2.00	1.60	-	2.60	2.80	1.20	4.00	2.50	-	25.80
22D	3.00	-	-	-	3.00	-	4.00	-	3.80	3.40	-	1.60	1.20	-	3.20	2.20	1.00	3.00	3.00	-	25.60
25D	-	-	-	-	2.25	-	2.20	-	3.20	3.00	-	1.50	1.40	-	2.80	2.60	1.00	2.00	2.00	-	20.00
29D	2.00	-	-	-	3.20	-	1.66	-	3.00	2.60	-	1.60	1.25	-	2.80	2.20	1.00	2.25	-	-	20.20
13D	-	-	-	-	3.00	-	2.33	-	3.20	3.00	2.00	1.40	1.80	-	3.00	2.25	1.00	-	2.60	-	21.40
63D	2.00	-	-	-	2.60	-	2.00	-	2.60	2.60	-	1.40	1.00	-	2.50	2.80	1.00	3.00	2.50	-	19.00
36D	-	-	-	-	2.66	-	2.75	-	3.80	3.00	-	1.80	1.80	-	2.80	2.50	1.00	2.00	2.00	-	21.60
60D	-	-	-	-	2.25	-	2.00	-	3.50	2.75	-	1.50	1.25	-	2.25	2.50	1.00	1.00	3.00	-	17.00
1D	-	-	-	-	3.50	-	2.25	-	4.00	2.80	-	1.50	1.60	-	3.20	2.75	1.00	2.00	2.50	-	19.90

Collection No. and Country	The mean volume of knobs at 20 knob-forming positions																				Mean Knob Volume
	1S a	1S b	1L	2S	2L	3S	3L	4S	4L	5L	6L a	6L b	6L c	7S	7L	8L a	8L b	9S	9L	10L	
Haiti																					
14J	1.00	-	-	-	4.00	-	4.50	-	3.50	2.00	-	1.00	1.50	-	2.50	2.50	1.00	4.50	3.00	-	29.00
27J	1.00	1.00	-	-	3.00	-	2.00	-	3.00	2.00	-	2.00	2.00	2.50	3.50	2.00	-	2.00	2.00	-	24.00
13J	2.00	-	-	-	3.00	-	2.00	-	2.50	3.00	-	1.00	1.00	-	2.50	2.50	1.00	3.00	3.00	-	21.00
17J	1.50	-	-	-	2.50	-	2.00	-	3.00	1.50	-	2.00	1.00	-	1.50	3.00	1.00	-	-	-	16.00
20J	-	-	-	-	2.00	-	2.00	-	2.00	2.50	-	2.00	1.50	-	2.00	2.00	1.00	2.00	2.50	-	17.00
1J	2.00	-	-	-	-	-	-	-	2.50	2.50	-	1.00	1.00	-	2.00	2.00	1.00	-	-	-	13.50
22J	-	-	-	-	3.00	-	2.00	-	3.00	2.00	-	1.50	1.00	-	2.50	2.00	-	5.00	2.00	-	17.00
2J	2.00	-	-	-	2.00	-	-	-	2.66	2.00	-	1.00	1.00	-	1.33	-	1.00	2.00	4.00	-	13.00
2	2.00	-	-	-	2.00	-	-	-	3.00	2.00	-	1.00	1.50	-	2.00	2.00	-	-	-	-	12.50
10J	2.00	-	-	-	-	-	-	-	2.50	2.00	-	1.00	2.00	-	2.00	2.50	1.00	-	-	-	12.00
23J	-	-	-	-	2.00	-	-	-	3.00	2.50	-	1.00	1.00	-	2.50	-	2.00	-	-	-	12.50
24J	-	-	-	-	3.00	-	-	-	2.00	2.00	-	-	1.00	-	3.00	2.00	-	1.50	2.00	-	12.50
7	2.00	-	-	-	-	-	-	-	2.50	2.00	-	-	1.00	-	3.00	2.00	1.00	-	-	-	11.50
Puerto Rico																					
15D	-	-	-	-	2.00	-	2.00	-	4.00	2.00	-	2.00	2.00	-	3.00	2.00	1.00	3.50	-	-	22.50
1D	-	-	-	-	3.50	-	2.00	-	3.00	2.00	-	2.00	2.00	-	3.50	2.00	1.00	-	-	-	19.50
3D	2.00	-	-	-	4.50	-	-	-	3.00	2.00	-	1.50	2.50	-	3.00	3.50	1.00	-	-	-	21.50
5D	-	-	-	-	3.50	-	1.50	-	3.50	2.50	-	1.00	1.50	-	4.50	3.00	1.00	-	-	-	19.00
14D	-	-	-	-	3.50	-	-	-	3.50	2.50	-	2.00	2.00	-	2.00	4.00	-	2.00	-	-	21.50
22D	-	-	-	-	2.50	-	3.00	-	3.00	3.50	3.00	2.00	2.00	-	2.50	3.00	1.00	-	-	-	21.00
20D	-	-	-	-	2.00	-	3.00	-	4.00	2.50	-	1.00	1.00	-	3.50	2.50	1.00	-	-	-	18.00
17D	-	-	-	-	2.50	-	-	-	3.50	2.50	-	1.50	2.00	-	2.50	2.00	-	1.00	-	-	16.00
8D	-	-	-	-	3.50	-	2.00	-	2.50	2.50	-	-	2.00	-	3.00	2.00	-	-	-	-	16.50
11D	-	-	-	-	3.50	-	-	-	3.50	2.50	-	-	3.00	-	3.50	3.00	-	-	-	-	19.00
21D	-	-	-	-	-	-	-	-	4.00	3.00	-	-	2.00	-	3.00	2.00	1.00	-	-	-	15.00
12D	-	-	-	-	-	-	-	-	3.00	3.00	-	1.00	2.00	-	2.50	2.00	-	-	-	-	13.00
Virgin Islands																					
4	2.00	-	-	-	3.50	-	2.33	-	4.00	3.25	-	1.00	-	2.00	2.75	2.25	1.00	-	-	-	19.25
St. Lucia																					
4D	-	-	-	-	2.00	-	2.00	-	3.00	3.50	-	1.50	2.00	-	2.50	3.00	-	-	-	-	20.50
2D	-	-	-	-	2.00	-	-	-	3.50	3.00	-	3.00	1.00	-	3.00	3.00	1.00	-	-	-	17.50
St. Croix																					
6D	-	-	-	-	4.20	-	2.20	-	4.00	3.60	2.00	2.00	1.66	3.00	3.20	2.60	1.25	3.00	2.00	-	27.40
4D	-	-	-	-	2.60	-	-	-	3.40	3.40	-	2.00	1.20	-	3.20	2.66	1.66	-	-	-	18.60
5D	-	1.00	-	-	3.33	-	3.00	-	3.80	3.20	-	1.50	2.00	-	3.33	2.80	1.40	-	-	-	18.40
Barbados																					
11D	3.33	-	-	-	3.80	-	2.75	-	3.60	3.80	-	2.00	1.60	4.50	3.20	4.20	1.00	3.40	3.00	-	37.40
10D	-	-	-	-	2.00	-	3.50	-	3.60	4.50	-	2.00	2.00	4.00	2.20	2.00	1.00	-	2.20	-	18.60
2D	-	-	-	-	1.66	-	3.00	-	3.60	3.25	-	2.00	2.00	2.00	3.20	2.60	-	-	3.00	-	19.00
St. Vincent																					
1D	2.00	-	-	-	2.50	-	3.50	-	4.00	4.00	-	2.00	2.00	2.00	3.00	4.00	1.00	-	2.00	-	32.50
3D	2.00	-	-	-	3.00	-	2.50	-	3.50	3.00	-	2.00	1.00	-	3.50	2.50	1.00	3.00	2.50	-	26.00
8D	-	-	-	-	3.00	-	2.00	-	3.50	2.50	-	-	2.00	3.00	3.50	3.00	1.00	3.00	-	-	24.00
6D	-	-	-	-	2.00	-	1.00	-	4.00	2.50	-	2.50	1.00	-	3.00	3.00	1.00	3.00	-	-	19.00
10D	2.00	-	-	-	3.00	-	4.00	-	4.50	2.00	-	2.00	1.00	-	2.50	2.00	-	-	3.00	-	20.50

Collection No. and Country	The mean volume of knobs at 20 knob-forming positions																				Mean Knob Volume
	1S a	1S b	1L	2S	2L	3S	3L	4S	4L	5L	6L a	6L b	6L c	7S	7L	8L a	8L b	9S	9L	10L	
Guadalupe																					
3D	2.00	1.00	-	2.00	2.00	-	2.40	-	2.80	2.80	2.00	1.40	1.25	2.50	2.40	2.40	1.00	2.50	2.00	-	24.40
4D	-	1.00	-	-	3.00	-	3.00	-	3.00	3.00	-	2.00	2.00	-	3.00	3.00	-	3.00	3.00	-	29.00
7D	2.25	-	-	-	1.33	-	2.00	-	3.00	3.00	-	1.40	1.00	2.00	2.80	2.50	1.00	1.60	2.25	-	21.00
8D	-	-	-	-	2.75	-	1.75	-	2.33	2.25	2.00	1.50	2.00	-	2.50	2.66	1.00	1.50	2.50	-	21.00
12D	1.66	-	-	-	2.80	-	3.00	-	2.00	2.00	-	2.00	1.00	-	2.20	2.00	1.00	2.00	2.00	-	18.00
10D	-	-	-	-	2.33	-	2.00	-	2.50	2.00	2.00	1.50	1.50	3.00	2.66	2.00	1.00	2.00	2.00	-	17.00
5D	3.00	1.00	-	-	3.00	-	2.00	-	3.00	3.00	-	1.50	1.25	2.00	2.80	2.25	1.00	-	2.00	-	16.40
Martinica																					
1D	-	-	-	-	4.00	-	2.00	-	3.50	2.00	-	2.50	1.50	-	3.00	2.50	1.00	3.00	2.00	-	25.50
Antigua																					
6D	2.00	-	-	-	3.75	-	2.25	-	3.80	3.60	3.00	2.00	2.00	3.50	3.80	2.80	1.20	4.60	1.00	-	32.60
3D	2.00	-	2.00	-	4.00	-	3.00	-	4.00	3.80	2.00	2.00	2.20	3.20	3.60	2.80	1.20	5.00	3.00	-	33.40
4D	-	-	-	-	3.80	-	2.00	-	4.00	3.00	2.50	2.40	2.20	3.75	3.20	3.00	1.00	4.00	1.50	-	30.60
Granada																					
17D	2.00	-	-	-	3.00	-	3.00	-	3.00	3.00	-	2.00	2.00	-	4.50	2.50	1.00	5.00	2.00	-	33.50
11D	2.00	-	-	-	2.33	-	3.00	-	-	2.33	2.50	1.66	2.00	3.00	3.66	3.66	1.00	3.66	2.66	-	31.00
7D	2.00	-	-	-	1.75	-	2.75	-	2.50	2.00	2.00	1.75	1.75	2.00	3.25	2.25	1.00	3.25	2.00	-	25.50
1D	2.25	-	-	-	3.00	-	3.25	-	3.50	2.50	2.00	1.25	2.50	-	3.00	3.00	1.00	2.00	2.00	-	27.80
13D	2.00	-	-	-	3.50	-	3.00	-	-	3.50	-	2.00	2.00	2.00	2.50	3.00	1.00	4.00	2.00	-	28.50
16D	2.00	-	-	-	2.66	-	2.50	-	3.00	2.33	-	2.00	1.33	-	3.00	2.66	1.00	4.50	3.00	-	24.30
9D	2.00	-	-	-	2.00	-	3.00	-	-	2.00	-	2.00	2.00	-	2.00	3.00	1.00	3.00	2.00	-	19.50
Tobago																					
6D	2.00	-	-	-	2.50	-	5.00	-	4.50	2.50	-	2.00	2.00	4.00	4.00	5.00	1.00	5.00	2.50	-	41.50
10D	3.00	-	-	-	4.33	-	5.00	-	4.00	4.00	-	2.33	2.00	2.66	4.00	4.00	1.00	3.33	3.00	-	40.66
4D	1.00	-	-	-	4.00	-	3.00	-	3.50	3.00	-	2.00	1.00	2.50	4.00	4.50	1.00	4.50	3.00	-	36.00
17D	2.50	-	-	-	3.50	-	5.00	-	4.50	5.00	-	2.00	2.50	3.50	4.50	3.50	1.00	2.00	-	-	38.00
2D	2.00	-	-	-	3.00	-	4.50	-	3.00	2.50	-	2.00	1.50	5.00	4.00	2.00	-	2.00	4.00	-	34.50
Trinidad																					
16D	2.00	-	-	2.00	3.00	-	3.66	-	3.66	3.66	-	1.66	2.33	3.00	3.33	4.00	1.00	3.66	3.00	-	37.33
8D	2.00	-	-	-	4.00	-	5.00	-	4.00	4.50	-	2.00	2.50	2.50	4.00	4.50	1.00	4.50	2.50	-	43.00
13D	2.00	-	-	-	4.00	-	4.50	-	5.00	3.50	-	2.00	2.00	5.00	3.00	5.00	1.00	4.00	2.00	-	43.00
2D	2.00	-	-	-	4.50	-	5.00	-	4.00	3.50	-	2.50	1.00	4.00	3.00	5.00	1.00	4.50	3.50	-	43.00
31D	3.50	-	-	-	5.00	-	5.00	-	5.00	5.00	-	2.00	2.00	5.00	4.00	5.00	1.00	5.00	4.50	-	49.50
33D	2.50	-	-	-	4.00	-	4.50	-	4.50	4.00	-	2.00	2.00	2.00	5.00	5.00	1.00	5.00	4.00	-	44.50
4D	2.00	-	-	-	3.50	-	5.00	-	5.00	4.00	-	2.00	1.50	3.00	5.00	4.50	1.00	4.00	2.50	-	40.00
6D	2.50	-	-	-	4.00	-	4.50	-	4.50	4.50	-	2.00	2.00	-	4.00	5.00	1.00	4.00	3.50	-	41.50
35D	2.00	-	-	-	4.50	-	5.00	-	4.00	4.00	-	2.00	1.50	2.00	5.00	4.50	1.00	4.00	3.50	-	40.00
1D	2.00	-	-	-	4.00	-	5.00	-	3.50	4.00	-	2.50	2.00	2.50	3.00	3.00	1.00	5.00	2.00	-	34.50

Table 4-c. Caribbean corn collections from 16 areas, showing mean knob numbers and prevalence of Ab-10 and B-type chromosomes.

Island area	No. of coll.	No. of plants	Mean knob No.	Plants with Ab-10	Total No. Ab-10	Plants with B-Type	Total No. B-Type
Jamaica	3	11	11.33	-	-	3	8
Cuba	22	110	10.10	6	6	5	6
Dom. Rep.	11	55	9.36	11	11	9	15
Haiti	13	38	7.73	1	1	-	-
Puerto Rico	13	39	7.33	5	5	1	1
Virgin Isl.	1	4	7.00	4	5	-	-
St. Lucia	2	8	7.50	-	-	-	-
St. Croix	3	15	7.93	-	-	-	-
Barbados	3	15	8.66	-	-	-	-
St. Vincent	5	15	9.40	-	-	1	1
Guadalupe	7	30	9.64	2	2	-	-
Martinica	1	3	10.00	-	-	-	-
Antigua	3	15	10.73	-	-	-	-
Granada	7	36	11.18	1	2	-	-
Tobago	5	21	12.06	1	1	-	-
Trinidad	10	26	12.38	2	2	-	-

Figure 1c. Diagram showing mean chromosome knob numbers for the Caribbean Islands.

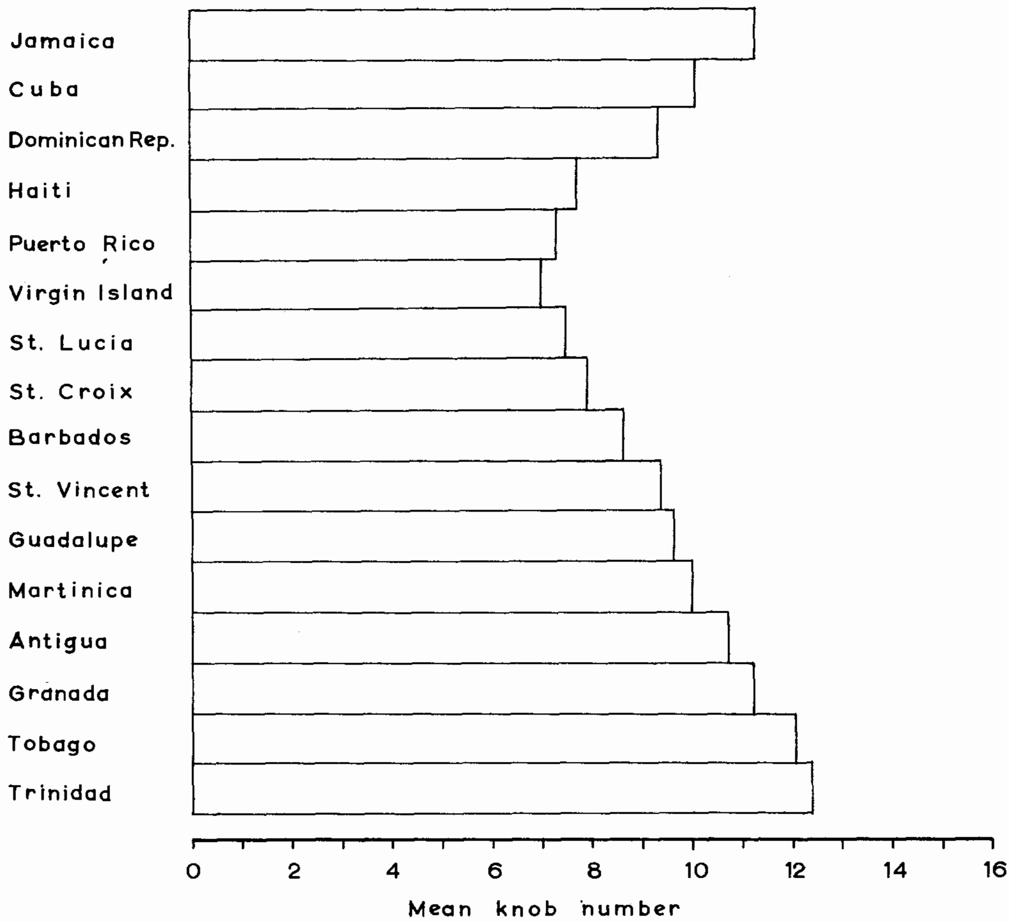


Figure 2c. Diagram showing mean knob number and the knob number variation (mid-line) for corn collections from Trinidad.

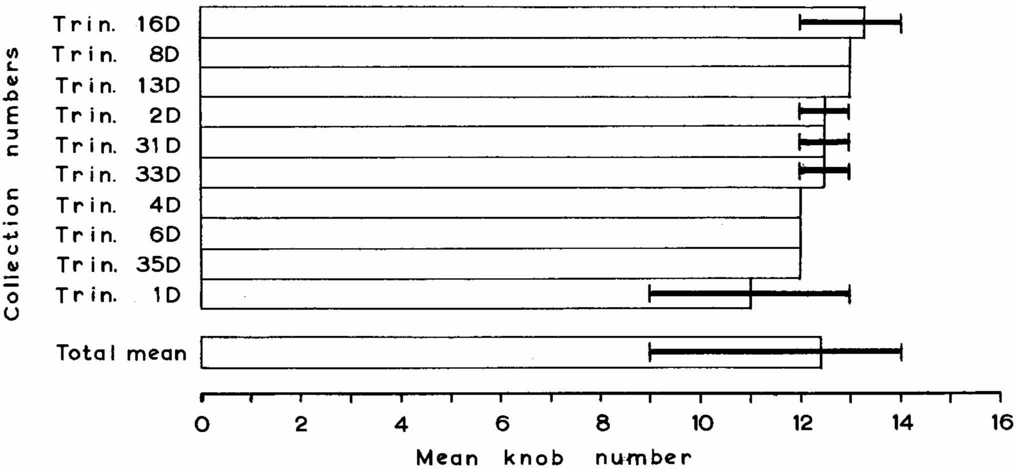


Figure 3c. Diagram showing mean knob number and the knob number variation (mid-line) for corn collections from Granada and Tobago.

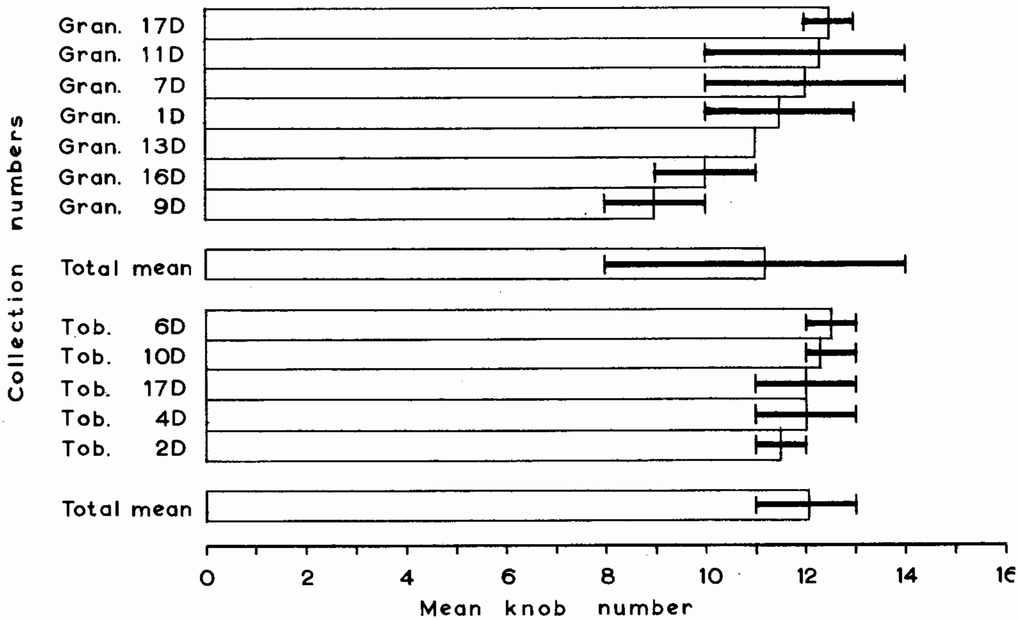


Figure 4c. Diagram showing mean knob number and the knob number variation (mid-line) for corn collections of the Coastal Tropical Flint race from different Caribbean areas.

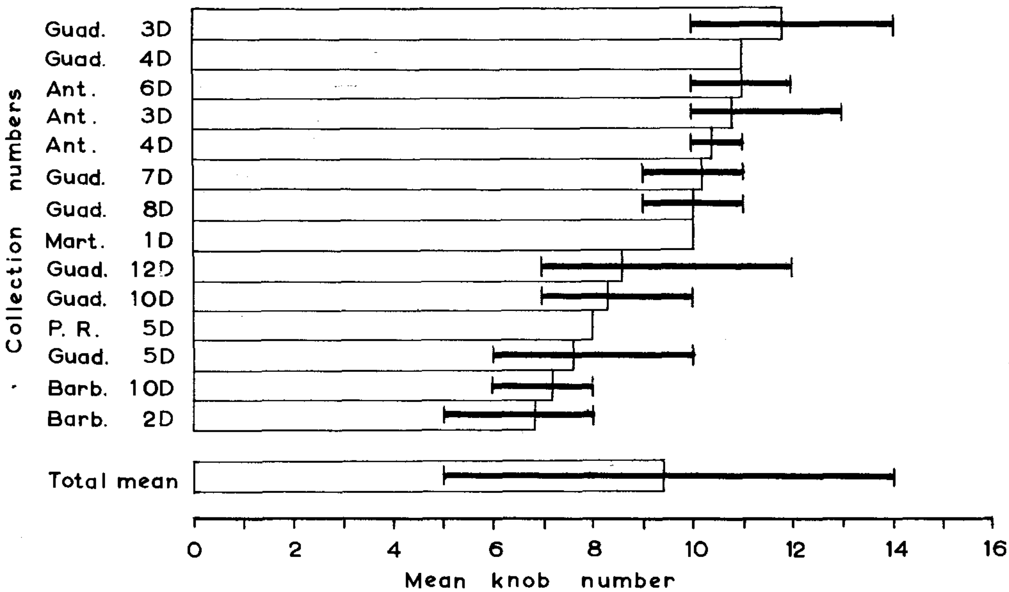


Figure 5c. Diagram showing mean knob number and the knob number variation (mid-line) for corn collections of the Chandelle race, mostly from the Dominican Republic.

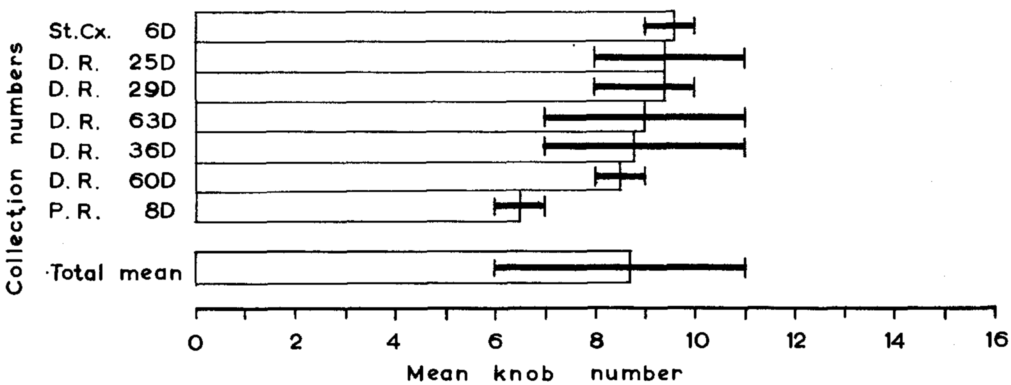


Figure 6c. Diagram showing mean knob number and the knob number variation (mid-line) of corn collections of the St. Croix race from different Caribbean areas.

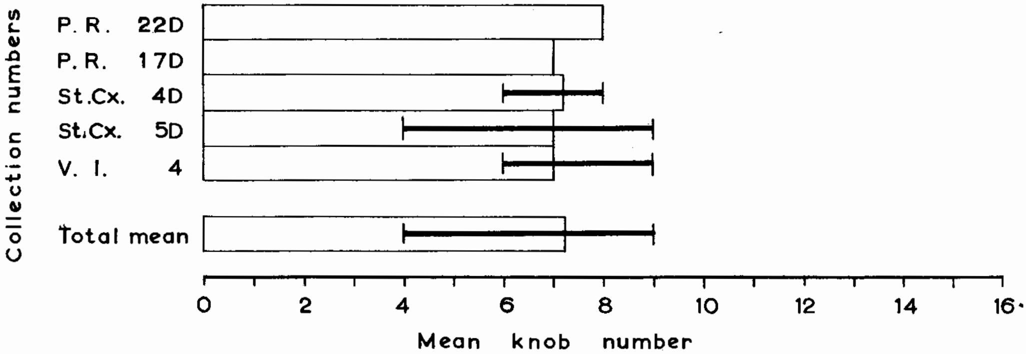


Figure 7c. Diagram showing mean knob number and the knob number variation (mid-line) of corn collections of the Haitian Yellow race from Haiti.

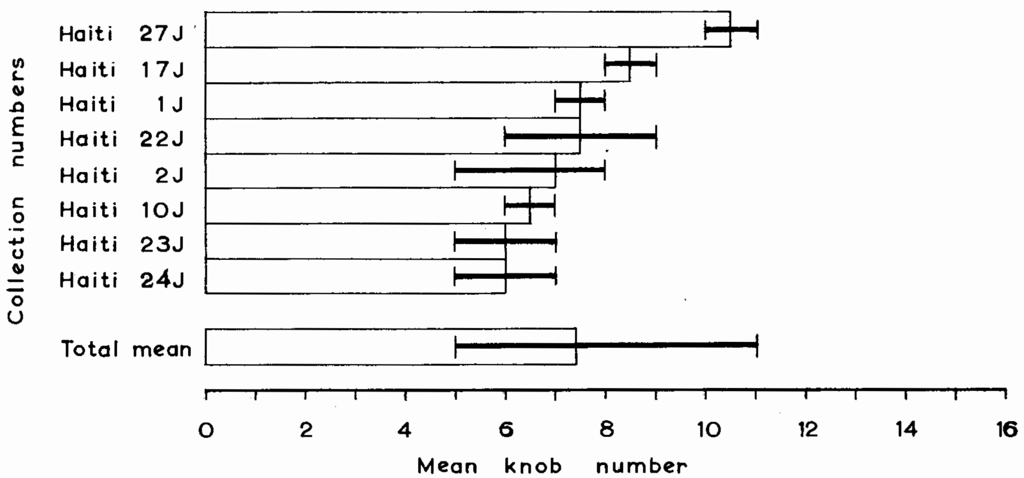


Figure 8c. Diagram showing mean knob number and the knob number variation (mid-line) of corn collections of the Cuban Flint race, both typical and atypical from Cuba.

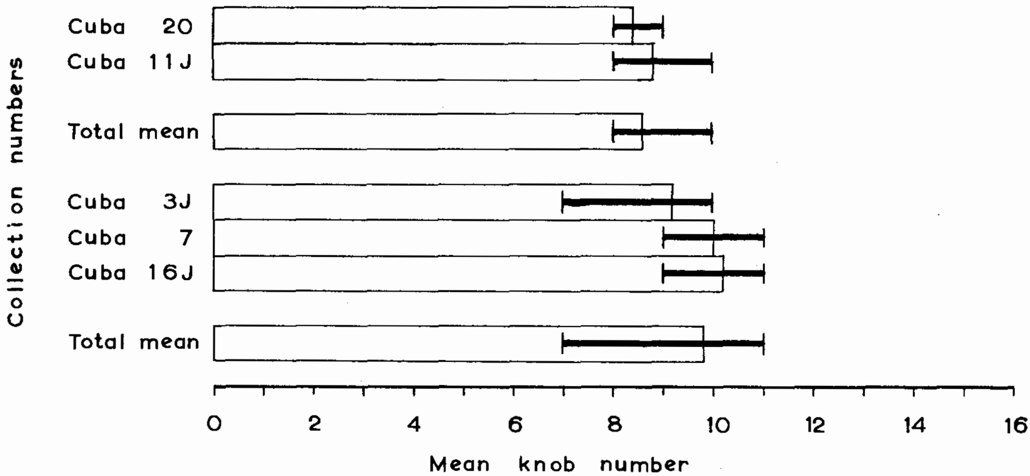
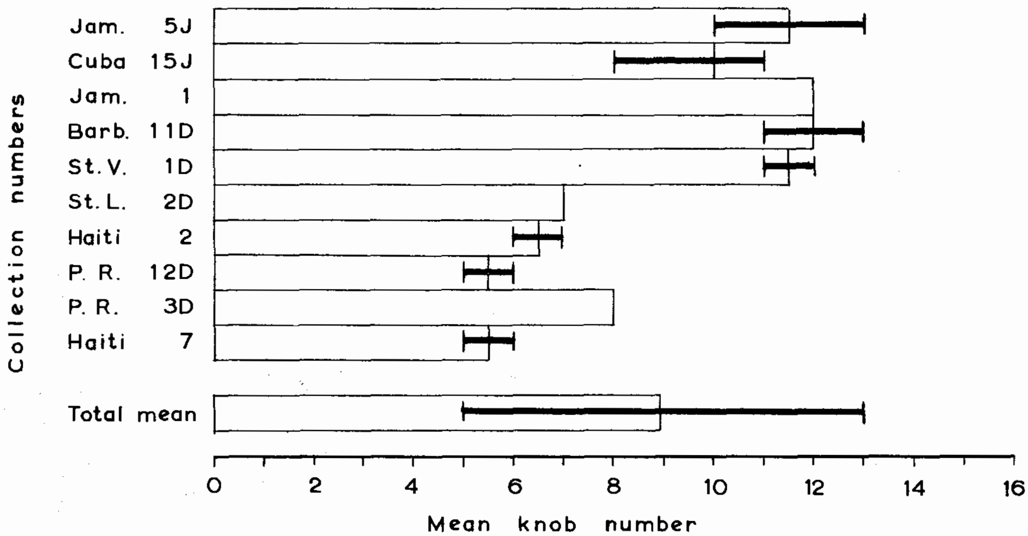


Figure 9c. Diagram showing mean knob number and the knob number variation (mid-line) of corn collections of the Flint Dent complex from different Caribbean areas.



SECTION D

DISCUSSION AND CONCLUSIONS

Albert E. Longley and Takeo A. Kato Y.

Discussions treating the cytological observations of the different characteristic markers on the pachytene chromosomes of corn, deserve the attention of corn geneticists and corn breeders. There should be a careful weighing of the data without bias. The end product should be a better understanding of the problems that intrigue those that make a study of corn both from basic and from an economic standpoint.

The questions concerning the origin of corn are being considered more realistically in the recent studies in this field. There exists a big gap in the available material on the transition from the wild ancestors of corn and the highly specialized varieties growing at the present time.

The synthetically produced intermediates between the present day relics of the genera closely related to corn and corn relatives should help to build a logical transition, but they may be quite misleading.

It is not necessary to turn to the wild for germplasm types that will be valuable in both, fundamental corn research and in practical corn improvement projects. There is still a wealth of variability and adaptability in some of the lesser specialized corn races prevalent today. Man is, however, anxious to unravel the web of the past and the web that is being spun for the future, hoping to add something to his knowledge in his urge to have a more productive and even a more adaptable cereal.

Chromosome research such as that is presented in these treatises, contributes to the basic knowledge, useful in determining relationship between certain chromosome complexes and other characteristics of the corn plant. The practical application of any new-found basic knowledge is likely to apply indirectly rather than directly to a corn improvement program.

Knobs, when present on the chromosomes of corn, are very useful markers for chromosome identification. They are, however, variable in number and size. The maximum knob-forming positions in our material has been 20, and each of the paired positions in the bivalent chromosomes has been given six grades of activity, ranging from 0-5. The activity of a position is measured by the differences in knob size. A particular knob size is constant and is transmitted in the usual Mendelian manner.

The term mutation suggests itself as one method of changing the activity at a knob-forming position and changing the size of the knob produced. The familiar name mutation is used because knobs behave like other genetic characters that mutate.

Knob-forming positions seem to have individuality because their rates of mutation and change are characteristically different for different positions. Some positions are quite stable, while others seem to change much more rapidly. The prevalence of a knob at a particular position is considered as a measure of stability. Figures were given for the differences in knob frequency in an early study of the knobs on the chromosome of corns of the North American Indians (8). Similar figures, including different knob sizes at each position, are given in Table 2d and illustrated in Figure 1d, for all collections of corns used in this study. The prevalence of corns from one area, in such a summary of data as given in Table 2d, may shift the overall prevalence of knobs sometimes up, sometimes down. When the data has been shifted in this manner, there is still a close agreement in an arrangement, such as that seen in Table 2d, so that it begins with position 7L and ends with 1Sb.

The observations recorded in Table 2d are the end product of different mutation rates at different knob-forming areas, combined with random knob transmission. If numbers are large enough, any knob may be found in any plant, but the chances of finding a knob at a knob-forming point having a high mutation rate, is very remote, if the total knob number is low in these plants.

A second method that could contribute to changes in both knob size and to knob numbers is an oblique exchange at or near a knob at the time of crossing over between paired chromosomes occurs. Such an exchange will produce a knob duplication in one chromosome and a deficiency in the other. The production of compound knobs and of large blocks of heterochromatin, such as are found in B-type and abnormal 10 chromosomes, has been treated in the introduction of this presentation.

The transmission of B-type chromosomes, except for non-disjunction in the divisions of the pollen grains, is a random transfer of this chromosome from generation to generation. Since a mutation in a compound knob will have a minor effect, the result is that this large block of heterochromatin on this odd chromosome remains practically unchanged. Corn strains may lose their A-type chromosome knobs, but will still retain B-type chromosomes. The B-type chromosome in a corn plant serves to tie this plant to the plant in which the B-type first appeared. Because these chromosomes are found in plants with from 17-0 chromosome knobs (Table 2d) and from almost every corn-growing area, their presence supports the idea that all corns spread from one center. The B-type chromosomes were present in the chromosome complement of corn before the spread from this center of origin began.

The abnormal type of chromosome 10, like the B-type chromosome, seems to persist with little evidence of mutational changes in its heterochromatic portion. It seems to follow the normal laws of transmission, with possible minor exceptions in the corns of the Latin Americas. In them, meiosis seem much more regular than when Ab-10 chromosomes were first observed in hybrids with genetic stocks of the United States. Tables 3 d and 7d give the frequency and distribution of these 2 chromosomes in the many collections examined.

The abnormal 10 chromosome has a more limited distribution than the B-type chromosome. It is found mostly in corns of the Caribbean Islands and the countries bordering this sea to the west and south. One report indicates that it has reached as far south as Ecuador (20). It should be kept in mind, however, that small samples of a collection, or even of an area, may be insufficient to be sure that either of these two odd chromosomes are absent from a corn race or from some particular area.

Chromosome knobs are prevalent on the chromosomes of the nearer wild relatives of maize. Isolated collections of both Euchlaena and Tripsacum are known to be knobless or almost knobless, but, in general, knobs are characteristic of most material studied coming from these two genera. Some students of the origin of maize consider that the chromosomes of primitive maize were marked by many knobs. (See L. F. Randolph's discussion of cytological aspects of the original evolutionary history of corn. Sprague (18).

The senior author found that tetraploid Euchlaena has almost knobless chromosomes (7). Prywer (14) has found that the rarer diploid Tripsacums frequently have only minor chromosome knob markings. These observations support an assumption that isolation due to exceptional chromosome numbers is responsible for the absence of knobs that are so characteristic in the more prevalent representatives of these two genera.

The assumption that isolation has played a role in the production of corns with low chromosome knob numbers, introduces the importance of past history for each corn collection investigated.

Data on the chromosomes of collections of primitive maize types are presented in Section "A" of this report. It is evident that the Palomero type which includes Pisankalla collections, have a low knob number. It is also evident that the collections of these types came from areas isolated from the high knobbed corns of the mid-highlands of Central America. The isolation was of two types: 1) in highland valleys and 2) geographical separation.

The highland valley type of isolation is prevalent in Guatemala and most collections from these valleys are characterized by having few chromosome knobs. A combination of geographical isolation and of religious ceremonial customs, could serve as an explanation of the low chromosome knob numbers found in several collections from Indian tribes of the S. W. United States (8). This low number is in sharp contrast to the high chromosome knob number found in collections from the recently introduced corns of the Apache and Navajo Indians.

There is much to support the view that corns much removed from Central America have low chromosome knob numbers. Studies of corns from the Northern United States (8), Colombia (17), Ecuador (20), Peru (4), Bolivia (15) and Chile (19), suggest that there is a reduction in chromosome knob number associated with an increase in distance north or south of Central America.

This treatment of chromosome knob data from the collections made in the Caribbean Islands, strongly suggests that water barriers served to isolate corn races, particularly where the islands were small. There is a suggested relationship between the distance from the mainlands to the N. W. and to the S. E., because, as the distance increases, the chromosome knob number decreases.

Isolation and inbreeding are synonymous and when they prevail in corn growing, they seem to lead to a loss of chromosome knobs. A verification of this suggested relationship by direct research is suggested, but the fact that nature's experiment has been active for a long time, and man's span of research time is, in comparison, short, discourages such a line of research. Wellhausen and Prywer (22), however, made a start by showing that cytological data from a selfing project reduced the chromosome knob number.

Brown (2) refers to two maize races, each with the same number of knobs, but which had distinct differences in the size of knob at the same position. A similar difference was found in the knobs of Euchlaena from Northern Guatemala and the knobs of this species from Southern Guatemala. This difference was also noted for the knobs of Nal-Tel collections No. 107 and No. 207. The former was from the north, the latter from the south of Guatemala, growing in approximately the same regions the Euchlaena materials were found. Such differences suggest the presence of suppressors that curtail the activity of all knob forming positions of a plant.

Brown (2) also found that similar plants could have quite different knob numbers. Such observations are not unusual, but they raise the question: can the race characteristics persist during chromosome knob losses? This would seem to be determined by the effort to retain racial characteristics. It seems feasible to retain the race type, even where contaminations occur frequently, thus a race will have a chromosome complex similar to corns of the area in which it has been grown. On the other hand, if these same racial types are maintained, but in an isolated area, time may produce a marked change in the chromosome knob complex.

The data presented at this time has several illustrations that suggest a different chromosome knob complex for collections of the same corn race. One illustration is the presence of both high and low knob numbers in collections of Negro de Chimaltenango and recently found in collections of Coastal Tropical Flint. The chromosome knob number vary from a mean of 6.8 to a mean of 11.2.

The foregoing illustrations do not necessarily prove that some one knob or a few knobs are linked with certain racial characteristics. The writers wish only to suggest the possibility that associations and not linkage between certain knob complexes and certain racial characteristics will serve to describe the true condition.

If these chromosome morphology studies have a practical application, it would seem to be due to an association between the chromosome knob number and the germplasm of a plant. This subject is presented in the following short paragraphs:

THE GERMPLASM OF MAIZE

The importance of retaining an all purpose type of germplasm in maize has only recently been emphasized.

The wild relatives that have persisted to the present time, have, in general, a germplasm that produces a plant capable of existing in the wild.

According to Beadle (1) and later Langham (6) in one, or possibly more than one of these relatives, was recognized a possible cereal grain. Selection started at this point and the germplasm was slightly restricted.

The next step began when early maize evolved. It lost from its germplasm, among other things, its ability to persist in the wild.

From the above primitive maize, improvements were selected. If free interchanges existed between these selections and a type persisted because of a certain plant, ear or seed character, the germplasm could continue without serious depletion.

The final step when isolation and inbreeding began, the germplasm and the number of knobs move together towards a restricted type and a reduced number respectively.

The assumed relationship between a depleted germplasm and a reduction in knobs has been supported by the knowledge that 20 positions on the chromosomes can be seen to have a changed activity. Likely, a much larger number of unseen points also change as maize goes from a high knobbed to a low knobbed level. Changes in points along a chromosome mean changes in the germplasm, and since the number of knobs on the chromosomes of a plant serve to measure the amount of change at different loci, it serves also to measure the amount of change in the germplasm.

Finally, these corn chromosome data suggest that the area populated by high knobbed corns is the area closest to the region where corn originated. It seems of interest that MacNeish (10) chose the mid-highland plateau to search for and later discover a primitive corn type.

Corn radiating from this center or these centers slowly had a decrease in chromosome knob number and the germplasm became more depleated. At the outer fringes of the corn growing belt, only these characteristics that nature required and more selected persisted.

Corns much removed, due either to environment or distance, from the center of origin, may have many desirable traits, but to be useful economically, such traits need to be fortified by the introduction of germplasm that is less modified and able to supply essentials for satisfactory mass production. A hybrid corn procedure in which nature has provided one inbred line.

Table 1-d. The number of knobs in different size classes in all corn collections. The per cent of knobs and the volume of knob material at each position is also given.

Position of knobs	All corn collections No. of knobs in each size class 5	4	3	2	1	0	% with knobs	Total knob vol.
7L	600	322	447	327	58	38	97.9	6341
5L	223	258	579	569	25	92	95.3	5047
4L	618	365	361	171	8	231	86.8	5883
8L a	324	270	501	353	43	296	83.5	4952
3L	481	250	352	251	27	411	82.4	5090
6L b	5	16	98	1070	295	337	81.5	2818
2L	326	302	435	318	13	342	80.3	4357
6L c	0	6	53	662	723	382	79.1	2230
9S	622	195	240	220	65	468	74.1	5115
8L b	0	0	0	157	1163	470	73.8	1477
1S a	24	25	146	865	69	649	62.6	2456
9L	49	74	199	364	80	1043	42.3	1946
2S	83	71	133	214	11	1230	28.8	1537
7S	29	23	66	267	19	1394	22.5	988
3S	27	34	61	85	3	1512	11.8	627
1L	1	0	9	57	15	1605	4.6	160
4S	0	1	4	47	1	1716	2.8	105
10L	0	0	0	20	33	1817	2.8	73
6L a	2	3	9	25	0	1790	2.1	99
1S b	0	0	0	3	15	1760	1.0	21

Table 2-d. Number and per cent of abnormal 10 and B-type chromosomes, and the knob volume, found in 1023 maize plants, with from 0-17 chromosome knobs.

No. Plants	No. Chromosome knob	Knob volume * Per Plant (mean)	Knob volume ** Per Knob (mean)	Plants with Ab-10 No.	Plants with Ab-10 %	Plants with B-type No.	Plants with B-type %
1	17	45.0	2.64	0	0.0	0	0.0
3	16	48.0	3.00	1	33.3	1	33.3
34	15	43.9	2.93	6	17.6	4	11.7
80	14	42.8	3.06	5	6.3	5	6.3
152	13	39.9	3.07	18	11.8	20	13.2
177	12	37.1	3.09	11	6.3	13	7.6
162	11	32.5	2.96	12	7.5	12	7.6
114	10	29.4	2.94	7	6.2	8	7.2
87	9	26.1	2.90	5	5.7	5	5.7
35	8	21.1	2.64	1	2.8	4	11.4
28	7	18.9	2.71	4	14.3	2	7.2
30	6	15.1	2.52	3	10.0	3	10.0
28	5	11.1	2.22		0.0	2	7.2
20	4	10.1	2.52		0.0	1	5.0
24	3	6.2	2.07		0.0	5	20.8
31	2	3.4	1.70		0.0	7	22.6
15	1	2.1	2.10		0.0	1	6.7
2	0	0.0	0.00		0.0	2	100.0
Total 1023				73	7.1	95	9.3

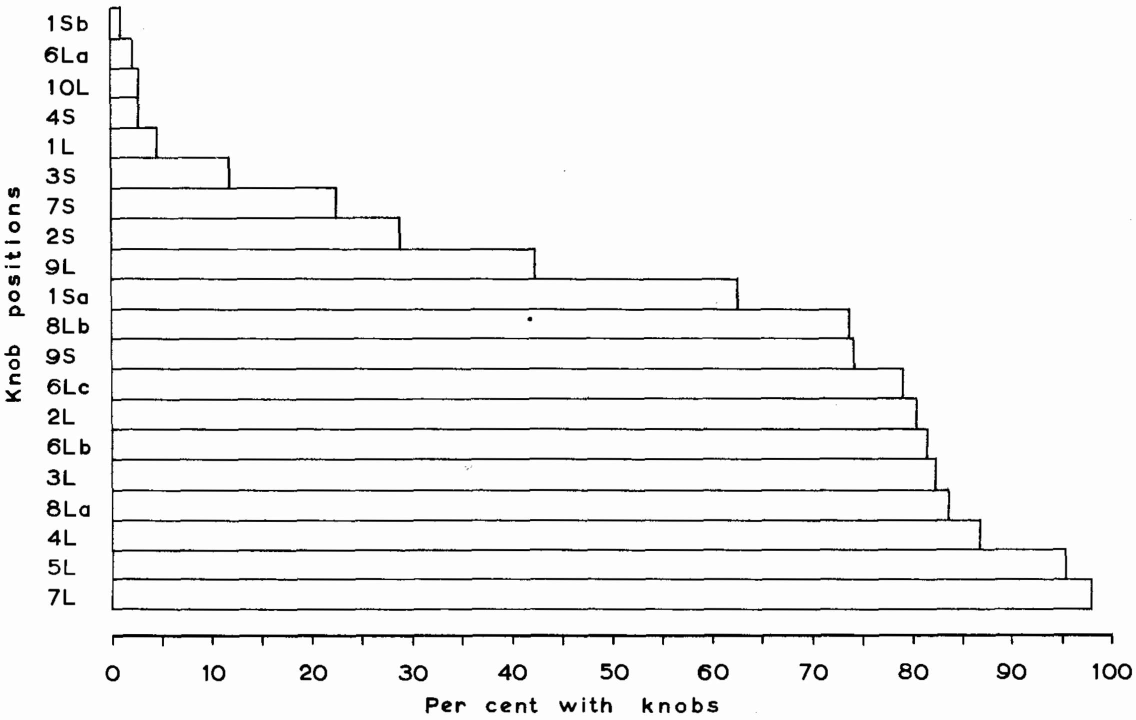
*100 is maximum

** 5 is maximum

Table 3-d. The prevalence, in per cent of the total number of plants from 8 geographical areas of the abnormal form of chromosome 10 and of B-Type chromosomes.

Country	Per cent of plants with Ab-10	B-T
Mexico (Section A)	5.0	14.0
Guatemala	10.0	5.0
El Salvador	13.3	26.6
Honduras	7.7	12.5
Nicaragua	7.7	12.3
Costa Rica	5.2	1.2
Panama	6.2	0.0
Caribbean Islands	6.2	4.2

Figure 1d. Diagram showing the frequency in per cent of knobs at each knob forming position. These percentages are for all material studied.



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A P P E N D I X

Table 1. Descriptions of maize collections used for chromosome studies which include mean chromosome knob numbers and mean volumes.

Collection No. and Country	Collection data: Place	Altitude (ft.)	Field Numbers	Chromosome knobs: Mean No.	Chromosome knobs: Mean vol.	Race, group or strain
Virgin Islands						
4	Christiansted, St. Croix	200	70Y	7.0	19.2	St. Croix
St. Lucia						
2D	Garah Daublin	660	87Y	7.0	17.5	Flint Dent
4D	Bonneterre, Gros Islet	60	88Y	8.0	20.5	Flint Dent
Puerto Rico						
1D	Esperanza Vega Allá	230	75Y	8.0	19.5	Dent
3D	Barrio del Coco, Quebrandella	230	76Y	8.0	21.5	Dent
5D	Barrio Guerrero Isabela	230	77Y	8.0	19.0	Coastal Tropical Flint
8D	Los Llanos, Coamo	595	78Y	6.5	16.5	Chandelle
11D	Honduras, Barranquitas	2040	79Y	6.0	19.0	Flint Dent
12D	Arenas Blancas, Neguabo	300	80Y	5.5	13.0	Dent Flint
14D	Mananá, Neguabo	265	81Y	8.0	21.5	Dent Flint
15D	Quebrada del Tajordo	330	82Y	9.5	22.5	Dent
17D	Guayama, Puerto Rico	300	83Y	7.0	16.0	St. Croix
20D	Cayey, Puerto Rico	460	84Y	7.5	18.0	Dent
21D	Agnadilla, Puerto Rico	560	85Y	6.0	15.0	Dent
22D	Aguada, Puerto Rico	100	86Y	8.0	21.0	St. Croix
Haiti						
2	Chambelan, Haiti	60	68Y	6.5	12.5	Flint Dent
7	Marfrane, Haiti	60	69Y	5.5	11.5	Semi Dent
1J	Montrouis, Trou-Baguette	60	57Y	7.5	13.5	Haitian Yellow
2J	Montrouis, Trou-Baguette	60	58Y	7.0	13.0	Haitian Yellow
10J	Gros Morne Gonaives, Dpto. L'Artigonite	760	59Y	6.5	12.0	Haitian Yellow
13J	Col. Grand Bassin, Dpto. Nort	265	60Y	9.5	21.0	Haitian Yellow - St. Croix
14J	Col. Grand Bassin, Dpto. Nort	265	61Y	11.0	29.0	Haitian Yellow - St. Croix
17J	Bois D'Homme, Dpto. Nort	1350	62Y	8.5	16.0	Haitian Yellow
20J	Dto. Miragoane, Dpto. Sur	990	63Y	8.5	17.0	Chandelle - Haitian Yellow
22J	Morriseau Aguin, Dpto. Sur	30	64Y	7.5	17.0	Haitian Yellow
23J	Moron Laferme, Dto. Jeremie, Dpto. Sur	660	65Y	6.0	12.5	Haitian Yellow
24J	Moron Laferme, Dto. Jeremie, Dpto. Sur	660	66Y	6.0	12.5	Haitian Yellow
27J	Labor de Plan Descayes, Dpto. Sur	60	67Y	10.5	24.0	Haitian Yellow
St. Croix						
4D	Colquhoun, Saint Croix	330	7Y	7.2	18.6	St. Croix
5D	Christiansted, Saint Croix	265	8Y	7.0	18.4	St. Croix
6D	Christiansted, Saint Croix	330	9Y	9.6	27.4	Chandelle
Barbados						
2D	Parroquia San José, Castle Grant	165	4Y	6.8	19.0	Coastal Tropical Flint
10D	Parroquia St. Phillip, Sun Bury	165	5Y	7.2	18.6	Coastal Tropical Flint
11D	Parroquia St. Phillip, Mount Pleasant	198	6Y	12.0	37.4	Coastal Tropical Flint - Tusón
Dominican Republic						
1D	Ingenio Cristobal Colón, Los Llanos	198	10Y	7.4	19.9	Chandelle
6D	El Ceibo, Las Parcelas	530	11Y	10.2	25.8	Dent - Chandelle
13D	Monseñor Novel, Hda. Bejucal	495	12Y	9.2	21.4	Dent - Chandelle
22D	Julia Molina, El Tablón	60	13Y	9.8	25.6	Dent - Chandelle
25D	Julia Molina, Batey Central, Las Parcelas	50	14Y	9.4	20.0	Chandelle
29D	Río San Juan, Pozo Prieto	15	15Y	9.4	20.2	Chandelle

Collection No. and Country	Collection data: Place	Altitude (ft.)	Field Numbers	Chromosome knobs: Mean No.	Chromosome knobs: Mean vol.	Race, group or strain
Dominican Republic						
36D	Valverde, El Junquito	165	16Y	8.8	21.6	Chandelle
50D	Monte Plata, Don Juan	100	17Y	10.6	25.8	Dent - Chandelle
60D	La Romana, Ingenio El Porvenir	165	18Y	8.5	17.0	Chandelle
63D	Banf, Prov. Trujillo Valdez	60	19Y	9.0	19.0	Chandelle
66D	Azua, Provincia Azua	720	20Y	10.6	26.4	Dent - Chandelle
St. Vincent						
1D	Ottley Hall, Kingstown	130	89Y	11.5	32.5	Coastal Tropical Flint - Dent
3D	Arnos Vale, St. George	265	90Y	10.5	26.0	Coastal Tropical Flint - Dent
6D	Cedars, Charlotte	265	91Y	8.0	19.0	Coastal Tropical Flint
8D	Barrouallie, St. Patrick	50	92Y	9.0	24.0	Coastal Tropical Flint - Chandelle
10D	Coulls Hill, St. David	330	93Y	8.0	20.5	Coastal Tropical Flint
Guadalupe						
3D	Petit Canal, Guadalupe	200	43Y	11.8	24.4	Coastal Tropical Flint
4D	Anse Bertrand, Guadalupe	330	44Y	11.0	29.0	Coastal Tropical Flint
5D	Anse Bertrand, Guadalupe	330	45Y	7.6	16.4	Coastal Tropical Flint
7D	Moule, Guadalupe	330	46Y	10.2	21.0	Coastal Tropical Flint
8D	Saint Francois, Guadalupe	330	47Y	10.0	21.0	Coastal Tropical Flint
10D	Gosier, Guadalupe	395	48Y	8.3	17.0	Coastal Tropical Flint
12D	Saint Rose, Guadalupe	265	49Y	8.6	18.0	Coastal Tropical Flint
Martinica						
1D	Font de France, Martinique	820	74Y	10.0	25.5	Coastal Tropical Flint
Cuba						
7	Lagunillas, Cienfuegos	-	35Y	10.0	24.2	Cuban Flint - Dent
9	Pinar del Río	-	36Y	10.4	22.0	Cuban Flint - Dent
11	Pinar del Río	-	37Y	10.6	25.8	Cuban Flint - Dent
17	Guanabana, Matanzas	-	38Y	10.4	22.4	Cuban Flint - Dent
20	Filipinas, Guantanamo	-	32N	8.4	32.2	Cuban Flint
28	Filipinas, Guantanamo	-	39Y	10.0	23.4	Flint - Dent
29	Filipinas, Guantanamo	-	40Y	10.0	26.0	Flint - Dent
43	Cuba	-	41Y	10.4	22.2	Cuban Flint - Dent
67	Holguin, Oriente	-	42Y	10.2	24.8	Dent - Flint
1J	Trilladera	460	21Y	10.4	25.6	Cuban Flint - Dent
2J	Arroyo Muerto, Victoria de las Tunas	265	22Y	9.2	19.0	Cuban Flint - Dent
3J	Arroyo Muerto, Victoria de las Tunas	265	23Y	9.2	21.0	Cuban Flint - Dent
5J	Cantimplora, Gibara	132	24Y	9.8	22.2	Cuban Flint - Dent
7J	Pedernal Holguin, Oriente	265	25Y	9.8	20.4	Cuban Flint - Dent
11J	Cupaicito, Jiguani	265	26Y	8.8	18.8	Cuban Flint
15J	Centro Agricola Ventas de Casanova, Contramaestre	265	27Y	10.0	24.8	Flint - Chandelle
16J	Centro Agricola Ventas de Casanova, Contramaestre	265	28Y	10.2	23.0	Cuban Flint - Chandelle
19J	Centro Agricola Ventas de Casanova, Contramaestre	265	29Y	11.0	25.2	Flint - Chandelle
20J	Almacén Quiñones, Contramaestre	265	30Y	10.2	24.4	Cuban Flint - Chandelle
22J	Almacen Quiñones, Contramaestre	265	31Y	10.2	23.2	Cuban Flint - Chandelle
23J	Almacen Quiñones, Contramaestre	265	32Y	12.0	24.7	Flint - Chandelle
24J	Almacen Quiñones, Contramaestre	265	33Y	9.4	19.8	Flint - Chandelle

Collection No. and Country	Collection data: Place	Altitude (ft.)	Field Numbers	Chromosome knobs: Mean No.	Chromosome knobs: Mean vol.	Race, group or strain
Cuba						
25J	Almacén Quiñones, Contramaestre	265	34Y	11.4	26.6	Flint - Chandelle
Antigua						
3D	Parroquia St. Phillip, Willikies Village	130	1Y	10.8	33.4	Coastal Tropical Flint
4D	Parroquia St. Phillip, Free Town	400	2Y	10.4	30.6	Coastal Tropical Flint
6D	Parroquia Saint John, Crosby's Mill	360	3Y	11.0	32.6	Coastal Tropical Flint
Granada						
1D	Saint George Belmont	100	50Y	11.5	27.8	Tuzón - Coastal Tropical Flint
7D	Caraucord Saint John Marigat	400	51Y	12.0	25.5	Tuzón - Coastal Tropical Flint
9D	Saint John Marigat	130	52Y	9.0	19.5	White Popcorn
11D	Uppermanli Saint Patricks	300	53Y	12.3	31.0	Tuzón - Coastal Tropical Flint
13D	Beause Jour Saint George	130	54Y	11.0	28.5	Tuzón - Coastal Tropical Flint
16D	Beause Jour Saint George	130	55Y	10.0	24.3	Tuzón - Coastal Tropical Flint
17D	Beause Jour Saint George	130	56Y	12.5	33.5	Ruzón - Coastal Tropical Flint
Jamaica						
1	Jamaica		73Y	12.0	36.0	Coastal Tropical Flint - Tuzón
1J	St. Ann, Jamaica	265	71Y	10.5	32.0	Coastal Tropical Flint - Tuzón
5J	Trelawny, Jamaica	1020	72Y	11.5	32.0	Coastal Tropical Flint - Tuzón
Tobago						
2D	Bogatalle Village, Scarborough	130	94Y	11.5	34.5	Tuzón - Coastal Tropical Flint
4D	Blen-Hiem, Blen-Hiem	30	95Y	12.0	36.0	Tuzón - Coastal Tropical Flint
6D	Mount Saint George	130	96Y	12.5	41.5	Tuzón - Coastal Tropical Flint
10D	Arnos Vale	100	97Y	12.3	40.6	Tuzón - Coastal Tropical Flint
17D	Delaford, Delaford	130	98Y	12.0	38.0	Tuzón - Coastal Tropical Flint
Trinidad						
1D	John Harry, St. Augustine	50	99Y	11.0	34.5	Tuzón
2D	Imp. College Trop. Agric. St. Augustine	30	100Y	12.5	43.0	Tuzón
4D	San Fernando Jardin	40	101Y	12.0	40.0	Tuzón
6D	Hermitage Jardin	50	102Y	12.0	41.5	Tuzón
8D	McBean Couva Rd. Jardin	100	103Y	13.0	43.0	Tuzón
13D	Fishing Pond, Sangre Grande	165	104Y	13.0	43.0	Tuzón
16D	Saint Chair, Arouca	130	105Y	13.3	37.3	Tuzón
31D	Guanapo Caroni	530	106Y	12.5	49.5	Tuzón
33D	Tableland, Saint Victoria		107Y	12.5	44.5	Tuzón
35D	Rio Claro, Mariva	265	108Y	12.0	40.0	Tuzón
Mexico						
5	Mexico - Toluca Km. 57		1A	2.2	6.2	Palomero Toluqueño
6	Toluca, Mexico		1B	1.6	3.2	Palomero Toluqueño
211	Toluca, Mexico		22	2.4	6.2	Palomero Toluqueño
Campeche						
18	Bolonchenticul, Campeche	100	1082	10.6	29.4	Nal-tel Blanco (some Tuxpeño)
29	Suctuo, Campeche		1083	9.0	23.8	Nal-tel Amarillo
37	Suctuc, Campeche		1084	8.6	22.8	Nal-tel Amarillo
39	Tiquimul, Campeche		1085	10.0	27.6	Nal-tel Amarillo
41c	Mixture of several collections		1086	9.8	27.6	Nal-tel Blanco (some Tuxpeño)
54	Pueblo Nuevo, Campeche		1087	10.0	26.7	Nal-tel Blanco (some Tuxpeño)
102	Lerma, Campeche	50	1088, 46N	11.1	32.7	Nal-tel
103	Lerma, Campeche	50	1089, 47N	10.0	29.3	Nal-tel

Collection No. and Country		Collection data		Field Numbers	Chromosome knobs		Race, group or strain
		Place	Altitude (ft.)		Mean No.	Mean vol.	
Chiapas							
	139	Altamirano, Chiapas	3630	1090	10.4	26.6	Nal-tel
	144	Altamirano, Chiapas	3630	1091	10.8	28.6	Nal-tel
	197	Bejucal de Ocampo, Chiapas	6270	1092	5.8	12.0	Small eared Yellow Dent-Flint (late)
Guerrero							
	17	El Treinta, Guerrero		37N	9.5	24.5	Nal-tel Blanco
	100	El Ocote, (N. Petatlán), Guerrero	595	38N	9.6	26.2	Nal-tel Blanco
	121	Real de Guadalupe, Guerrero	3300	39N	10.2	34.8	Nal-tel Blanco
	168	San Marcos, Guerrero	165	40N	9.6	28.2	Nal-tel Blanco
	174	Zacualpa, Guerrero	990	41N	11.1	33.6	Nal-tel Amarillo
	177	Zacualpa, Guerrero	990	42N	9.2	26.8	Nal-tel Blanco
Oaxaca							
	148	Jicaltepec, Oaxaca	-	43N	10.9	33.8	Nal-tel Amarillo
	171	Pinoteoa Nacional, Oaxaca	-	44N	12.2	39.4	Nal-tel Amarillo
	174	Jicaltepec, Oaxaca	-	45N	11.0	31.6	Nal-tel Amarillo
Sinaloa							
	2	Culiacán, Sinaloa	-	51N	11.0	38.0	Chapalote
	6	El Fuerte, Sinaloa	-	52N	10.8	35.8	Chapalote
Sonora	27	Ures, Sonora	1450	53N	12.6	41.8	Chapalote - Reventador - Harinoso de Ocho
	55	Bacanora, Sonora	990	54N	12.6	40.4	Chapalote - Harinoso de Ocho
Yucatán							
	7	Dzitás, Yucatán	100	1093, 48N	9.8	30.1	Nal-tel Amarillo
	36	Muna, Yucatán	330	1094	10.2	27.4	Nal-tel Amarillo
	37	Muna, Yucatán	330	1095	10.2	28.0	Dzit Bacal - Nal-tel
	75	Dzitás, Yucatán	100	1096	10.2	26.0	Nal-tel Amarillo
	102	Yohdzonot, Yucatán	100	1097	9.6	25.8	Nal-tel Amarillo
	129	Becanchén, Yucatán	330	49N	11.0	33.1	Nal-tel
	146	Techac Pueblo, Yucatán	100	1098	10.5	30.6	Nal-tel
	148	Oxkutzcab, Yucatán	100	50N	10.2	35.0	Nal-tel
Guatemala							
	4	Todos Santos, Huehuetenango	6000	277	11.5	35.5	Olotón - Nal-tel
	8	Concepción, Huehuetenango	7-8000	280	5.0	12.0	Quicheño
	14	San Sebastián, Huehuetenango	8-9000	227	2.0	3.5	Serrano
	20	Chiquiral, Quetzaltenango	8000	229	11.5	36.0	Nal-tel Blanco
	22	Cobán, Alta Verapaz	4-5000	1072	4.6	10.8	Negro Tierra Fría
	27	Civija, Baja Verapaz	4000	284	8.6	24.0	Olotón
	31	Mebaj, El Quiché	6000	272	7.0	15.5	Negro (Ch) (F)
	37	Mebaj, El Quiché	6-7500	274	3.0	8.0	Quicheño
	52	Jacaltenango, Huehuetenango	2-4500	1070	12.0	33.7	Nal-tel Blanco
	60	Hda. Orizaba, Malacatan	950	2245	12.0	30.5	Tuxpeño
	68	El Acintal, Quetzaltenango	1200	11N	12.8	47.6	Nal-tel Blanco
	69	Prov. El Acintal, Quetzaltenango	1350	2340	13.0	43.6	Tuxpeño - Coastal Tropical Flint
	71	Cantón, San José	950	2275	13.0	40.5	Tepecintle - Salvadoreño
	72	Turulá, Retalhuleu	1000	2338	13.5	42.5	Flint
	74	Río Bravo, Escuintla	700	2324	10.0	34.0	Flint - flour
	77	Zaracina Sto. Domingo, Suchitepequez	950	2308	13.0	36.0	Flint - Dent

Collection No. and Country	Collection data: Place	Altitude (ft.)	Field Numbers	Chromosome knobs: Mean No.	Chromosome knobs: Mean vol.	Race, group or strain
Guatemala						
79	San Miguel Ranan, Suchitepequez	900	2374	14.0	44.0	Tepecintle
81	Río Bravo, Escuintla	500	2310	11.5	35.0	Coastal Tropical Flint - Tuzón
85	El Recuerdo Siguinala, Escuintla	1100	2269, 12N	12.5	40.3	Nal-tel Salvadoreño
87	La Democracia, Escuintla	600	2312	11.0	37.0	Semi-Dent
88	Chiquimulila, Sta. Rosa	1200	2239	13.5	44.0	Tepecintle - Tuxpeño
90	San Agustín, El Progreso	1800	2178	13.5	45.0	Nal-tel - Tepecintle
92	Acasagustlán, El Progreso	1475	2325	12.0	42.0	Nal-tel - Salvadoreño
100	Puerto Barrios, Izabal	200	2235	13.0	43.5	Salvadoreño - Tepecintle
103	Puerto Barrios, Izabal	200	2248	12.0	36.0	Tepecintle - Salvadoreño
105	El Ronchito Gualan Zacapa	400	2168	12.5	39.0	Salvadoreño - Tepecintle
106	La Rueda, Quezaltepeque	4500	278	14.0	48.0	Salvadoreño - Tepecintle
107	Chatun Vado Hondo, Chiquimula	1500	2184	13.5	41.5	Salvadoreño - Tepecintle
108	San Juan Ermita, Chiquimula	1850	2230	12.0	40.0	Olotillo
109	Sica Vado Hondo, Chiquimula	1600	2185	12.5	42.5	Salvadoreño - Tepecintle
110	Sta. Elena Chiquimula	1500	13N	13.0	38.6	Salvadoreño - Tepecintle
111	Quezatlepeque, Chiquimula	3000	14N	14.7	42.0	Salvadoreño - Tepecintle
114	El Calvario Ipala, Chiquimula	2900	15N	13.0	42.2	Salvadoreño - Tepecintle
115	Cruz de Villada, Ipala, Chiquimula	2800	2326	11.0	37.5	Nal-tel Amarillo
116	Pansuma Jilotepec, Jalapa	2700	2193	12.0	38.5	Salvadoreño - Tepecintle
120	Finca El Zapote, Escuintla	2400	2267,289	11.8	37.2	Tepecintle - Salvadoreño
123	San José El Golfo, Guatemala	3200	2217	13.5	43.5	Salvadoreño - Tepecintle
129	El Progreso, Jutiapa	3650	2158	13.0	42.0	Salvadoreño - Tepecintle
130	Teucalmita, Jutiapa	2000	16N	10.6	34.8	Dzit Bacal - Olotillo
131	Asunción Mita, Jutiapa	2400	17N	10.8	33.6	Dzit Bacal - Olotillo
133	Amayo Sito, Jutiapa	3600	2223	11.6	38.0	Tuxpeño - Olotillo
134	El Barril, Jutiapa	3200	293	12.5	37.5	Dzit Bacal - Tuxpeño
135	Los Esclavos, Sta. Rosa	3000	290	12.0	38.5	Tepecintle - Salvadoreño
143	Pachalum Rabinal, Baja Verapaz	3400	2356	11.5	40.5	Nal-tel Blanco-Amarillo
145	San Sebastián Rabinal, B. Verapaz	3200	18N	12.0	45.0	Nal-tel Blanco
148	Paoj Chategua Rabinal, B. Verapaz	4800	2160	12.0	34.0	Nal-tel-Salvadoreño
151	San Juan Jacate, Sta. Rosa	2900	2264	13.0	40.0	Nal-tel - Salvadoreño
155	Sn. Agustín Chocolá, Suchitepequez	2200	2260	12.0	36.5	Tepecintle - Salvadoreño
158	Sto. Tomás, Suchitepequez	3500	19N	12.0	37.6	Tepecintle - Salvadoreño
160	Sn. Pedro Jocopilas, El Quiché	6100	249	12.0	44.5	Nal-tel Amarillo
161	Sn. Pedro Jocopilas, El Quiché	6000	1076, 267	11.1	33.0	Nal-tel Blanco
164	Sn. Pedro Jocopilas, El Quiché	5750	268	12.0	33.0	Nal-tel Blanco
174	Colima, San Marcos	2800	2316	11.5	39.0	Tepecintle - Salvadoreño
178	San Isidro Malacatán, San Marcos	1300	2319, 295	13.0	42.0	Tepecintle - Salvadoreño
179	Ayutla, San Marcos	300	2315	13.0	44.0	Tepecintle - Salvadoreño
187	San Siguan Cunin, Suchitepequez	6400	262	8.5	21.5	Olotón

Collection No. and Country	Collection data: Place	Altitude (ft.)	Field Numbers	Chromosome knobs: Mean No.	Chromosome knobs: Mean vol.	Race, group or strain
Guatemala						
207	El Tambor, El Progreso	925	20N	11.6	39.4	Nal-tel - Tepecintle
209	El Alto, Zacapa	720	2335, 296	9.0	28.2	Cuban Flint
210	Aldea Las Carretas, Zacapa	710	2169	13.5	40.0	Salvadoreño - Tepecintle
220	Quetzaltepeque, Chiquimula	2600	21N	12.8	39.4	Nal-tel - Salvadoreño
225	San Pedro Pinula, Jalapa	3700	2167	10.0	27.5	Nal-tel Blanco-Amarillo
226	Llano Grande, Jalapa	4550	2194	14.0	43.5	Salvadoreño - Tepecintle
229	La Campana, Jalapa	3300	2155	12.0	35.0	Nal-tel - Salvadoreño
231	Argelia Quezada, Jutiapa	3250	2232	11.0	35.5	Comiteco - Salvadoreño
239	Viñas Barberena, Sta. Rosa	3650	2251	13.0	42.0	Comiteco - Tepecintle
242	El Barrial, Jutiapa	3300	2332	11.0	32.5	Nal-tel - Salvadoreño
253	Espíritu Santo, El Progreso	1100	2177	12.0	39.5	Salvadoreño - Tepecintle
257	Los Esclavos, Sta. Rosa	3000	2342	9.0	23.3	Cuban Flint - Dent
259	Chixay Uspantán, El Quiché	2000	1077	13.0	37.8	Nal-tel Blanco-Negro
260	Buena Vista, Jutiapa	3650	2159	12.0	36.5	Nal-tel Blanco
262	Las Carretas, Zacapa	1100	2333	13.0	37.0	Salvadoreño - Tepecintle
269	Chicanay Esquipulas, Chiquimula	4750	22N	12.1	43.7	Nal-tel Ocho
279	Canastas Grandes, B. Verapaz	3400	2351	12.5	40.0	Nal-tel-Salvadoreño
280	El Progreso, Jutiapa	3500	2200, 23N	12.5	41.5	Nal-tel-Salvadoreño
281	Quezada, Jutiapa	3650	24N	11.2	37.4	Nal-tel - Salvadoreño
296	Quetzaltepequez, Chiquimula	2200	2209	13.5	44.0	Salvadoreño - Tepecintle
298	Pital Hda. Colonia Cuilapa, Sta. Rosa	4650	2240	12.5	38.0	Salvadoreño - Tepecintle
313	La Democracia, Jalapa	4500	2192	13.0	41.5	Salvadoreño - Tepecintle
314	Virginia Sn. Pablo, San Marcos	1600	2231	12.0	34.5	Olotillo - Tuxpeño
316	La Iragua, Zacapa	1300	2201	12.0	38.5	Salvadoreño
320	Finca Variedades Bravo, Escuintla	1000	2311	9.5	26.0	Coastal Tropical Flint
321	Sto. Tomás Unión, Suchitepequez	3500	2320	11.5	38.5	Coastal Tropical Flint
322	San Antonio Monjas, Jalapa	3500	292	13.5	42.0	Dzit Bacal - Tepecintle
326	San Jacinto Mojados, Chiquimula	1500	294	15.5	53.0	Nal-tel Blanco Tierra Caliente - Negro
329	Guacal, Zacapa	700	2202, 25N	11.6	39.3	Salvadoreño (Chimaltenango
330	San Jerónimo Coatepequez	500	2313	12.5	38.0	Tuxpeño - Coastal Tropical Flint
331	Chiramay Quetzaltepeque, Chiquimula	4600	26N	12.6	40.6	Salvadoreño - Tepecintle
333	Machaca Pto. Barrios, Izabal	128	2284	14.0	42.5	Tepecintle
338	San Jacinto, Chiquimula	1800	2152	11.5	35.0	Salvadoreño
344	Cabañas, Zacapa	1200	2334	11.0	36.7	Salvadoreño - Tepecintle
349	Colima Jilotepec, Chiquimula	1600	2341, 27N	12.7	40.4	Tepecintle - Nal-tel
351	Sn. Rafael P. Cuesta, San Marcos	2750	258	11.5	33.0	Unclassified
359	Finca La Unión	3450	288	13.5	43.5	Negro (C)
382	San Andrés Simitabay, Sololá	6725	266	6.0	12.5	Olotón
386	Palestina Los Altos, Quetzaltenango	8800	232	4.0	10.5	Negro
393	Godínes, Sololá	7425	271	8.0	24.5	Negro (Ch) (F)

Collection No. and Country	Collection data: Place	Altitude (ft.)	Field Numbers	Chromosome knobs: Mean No.	Chromosome knobs: Mean vol.	Race, group or strain
Guatemala						
413	Cantón Zantin, Totonicapan	8100	236	4.0	9.0	Serrano
423	San Pedro, San Marcos	7900	238	2.5	4.0	San Marceño
426	Sn. Pedro Necta, Huehuetenango	6050	260	12.0	37.5	Nal-tel Blanco-Amarillo
427	Sn. Pedro Sac., San Marcos	7800	240	3.0	6.5	San Marceño
431	Recuerdo Barrios Lija, Huehuetenango	9200	237	5.0	9.5	Serrano
448	Boca del Pasín, El Petén	100	1081	9.8	24.4	Salvadoreño
455	Godines, Sololá	7375	253	7.5	18.0	Serrano
458	Santiago Buena Vista, San Marcos	8300	1080, 245	4.1	6.4	San Marceño
459	Salina La Anchura, El Petén	100	2357	10.0	30.0	Comiteco
461	San Pedro Sac., San Marcos	7800	244	4.5	9.5	San Marceño
465	San Pedro Sac., San Marcos	7810	242	5.5	11.5	San Marceño
473	Salina La Anchura, El Petén	100	2361	10.0	32.5	Comiteco
477	San Raymundo, Guatemala	6000	279	8.5	18.5	Comiteco
480	Labor San José, Quetzaltenango	7600	269	7.0	14.5	Negro - Tierra Fría
491	San Pedro Sac., San Marcos	7850	243	3.3	6.6	San Marceño
492	San Pedro Sac., San Marcos	8800	228	3.5	5.0	Serrano
497	Cantón Chachequín, Quetzaltenango	8700	230	6.0	11.0	Serrano
500	Tierra Blanca Momostenango, Totonicapan	9100	28N	11.2	35.8	Nal-tel - Tierra Fría
508	Ixep Lucas Sac., San Marcos	7750	252	9.0	26.5	Serrano
513	San Cristobal, Totonicapan	9100	233	4.0	6.5	Negro - Tierra Fría
522	San Lorenzo, San Marcos	9000	234	5.0	11.0	Negro - Tierra Fría
529	Sn. Ildefonso Ixtahuacán, Huehuetenango	5250	259	11.5	36.5	Tepecintle
539	Escuela de Agricultura, Guatemala	8450	263	9.5	21.5	Olotón
544	Salina Anchura, El Petén	100	2302	10.0	20.5	Salvadoreño - Tepecintle
552	Sta. Lucía Cozumalguapa	800	2268	11.0	37.6	Salvadoreño
564	Cubillá Tejutla, San Marcos	800	246	3.0	8.0	San Marceño
573	Sacanba Panzós, Alta Verapaz	600	1073,2288	11.5	32.7	Salvadoreño
576	Pachimolín Patzún, Chimaltenango	7600	264	8.5	17.5	Olotón
577	Coxoc, Sololá	8125	282	8.5	18.0	Salpor
581	Aguazapa Barbera, Sta. Rosa	2800	2259	13.5	36.5	Comiteco - Salvadoreño
583	Patzún, Chimaltenango	7500	257	6.5	16.0	Olotón
590	Comalapa, Chimaltenango	7100	270	7.0	19.5	Negro Chimaltenango - Tierra Fría
591	Comalapa, Chimaltenango	7100	256	10.0	23.0	Nal-tel Ocho
594	Viñas Barberena, Sta. Rosa	3400	2344	13.0	43.5	Tepecintle
596	Tuichilupe Comitancillo, San Marcos	9850	239	5.5	10.5	Serrano
597	Chapinas Monterrey, Sacatepequez	500	291	13.0	42.0	Tepecintle
600	Salamá, Baja Verapaz	3200	2355	13.0	42.5	Olotillo
603	Salamá, Baja Verapaz	3200	287	10.5	31.0	Negro - Tierra Caliente
607	Raleles San Andrés, Sololá	6700	261	5.0	13.0	Olotón
619	Quimuy Comalapa, Chimaltenango	7100	254	5.0	11.5	Serrano

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Guatemala						
635	La Cumbre, Jalapa	5450	286	9.3	22.3	Negro
637	El Tablón, Sololá	8000	235	8.0	18.0	Serrano
642	Concepción, Sacatepequez	7150	265	10.0	24.0	Comiteco
647	El Tablón, Sololá	8000	29N	5.6	14.8	Serrano
649	Fca. Viñas Barberena, Sta. Rosa	3150	2252	13.0	45.5	Tepecintle
651	Balen San Cristobal, A. Verapaz	4000	2373	9.6	25.6	Tepecintle
674	San Juan Chamulco, A. Verapaz	4500	283	4.5	8.5	Olotón
678	San Cristobal, A. Verapaz	4500	276	8.0	15.0	Olotón
704	Panzós, A. Verapaz	4000	2309	8.0	21.5	Coastal Tropical Flint - Cuban Flint
705	Quizagá Poaquil, Chimaltenango	7300	255	7.5	20.0	Olotón
710	Salamá, B. Verapaz	3200	1074	13.0	40.6	Unclassified
738	San Felipe Ren, Retalhuleu	2260	2281	13.5	39.0	Tepecintle
742	San Pedro, San Marcos	7650	241	5.7	11.6	San Marceño
744	Alvarado Halacatancito, Huehuetenango	6200	250	12.0	38.6	Dzit Bacal
746	San Felipe Ren, Retalhuleu	2260	2339	9.0	24.0	Tuxpeño - Salvadoreño
760	Aguazapa Baile, Sta. Rosa	2800	2343	11.5	38.5	Comiteco - Salvadoreño
765	El Progreso, Jutiapa	3250	2166, 30N	11.7	39.2	Salvadoreño
769	Salamá, B. Verapaz	3200	2349	14.0	51.5	Dzit Bacal
778	Salamá, B. Verapaz	3200	2218	13.5	44.5	Salvadoreño - Tepecintle
793	San Cristobal, A. Verapaz	2000	2299	12.0	37.5	Salvadoreño
806	Panzós, A. Verapaz	400	2375	10.0	31.5	Tepecintle
809	San Pedro Carohá, A. Verapaz	400	2290	11.0	33.5	Tuxpeño
820	Balen Sn. Cristobal, A. Verapaz	4000	1075	12.4	32.6	Negro Chimaltenango
821	Panzós, A. Verapaz	400	2295	11.5	31.0	Salvadoreño
835	Uspantán, El Quiché	7500	1078	5.6	10.8	Quicheño
841	Sta. Gertrudis, El Quiché	4500	297	9.0	33.0	Cuban Flint
852	Uspantán, El Quiché	7500	31N	4.4	13.0	Quicheño
875	Zacualpa, El Quiché	5125	1079	13.3	39.6	Dzit Bacal
895	Serchil, San Marcos	10000	226	4.0	8.0	Serrano
902	Ixtiapoc Solomá, Huehuetenango	7500	275	3.5	9.0	Olotón
908	Chicux, Totonicapan	7650	247	6.7	14.0	Quicheño
909	Serchil, San Marcos	10000	231	4.5	10.0	Serrano
924	San Pedro Solomá, Huehuetenango	7700	273	6.0	15.5	Quicheño (G)
934	Ixtiapa Solomá, Huehuetenango	7500	248	4.5	10.0	Quicheño
937	Sn. Marcos Jacaltenango, Huehuetenango	4500	285	11.5	30.5	Unclassified
944	Chinique, El Quiché	6600	251	8.0	23.5	Quicheño
Salvador						
9	Villa El Carmen, El Salvador	2770	33N	12.0	50.0	Nal-tel - Salvadoreño
29	Cantón Talpetate, El Salvador	495	34N	11.4	41.6	Nal-tel - Salvadoreño
6J	El Pay Citala, Chalatenango	2310	167K	11.4	30.0	Salvadoreño
13J	Cantón Cuemay, Camanas, Sta. Ana	1850	158K	13.0	39.8	Salvadoreño

Collection No. and Country	Collection data: Place	Altitude (ft.)	Field Numbers	Chromosome knobs: Mean No.	Mean vol.	Race, group or strain
Salvador						
30J	La Bóveda, Depto. La Unión	330	168K	12.6	39.6	Salvadoreño
54J	Cantón, Cucumay, Camones, Sta. Ana	1850	176K	10.8	34.8	Salvadoreño
59J	Departamento Metapán	1650	166K	11.6	34.8	Salvadoreño
65J	Cantón El Triunfo, Fco. Morazán	790	171K	11.6	37.6	Salvadoreño
71J	Estación Experimental San Andrés	1350	157K	13.2	39.6	Salvadoreño
Honduras						
3J	Las Tapias, Fco. Morazán	6600	183K	10.6	30.4	Salvadoreño - Tepecintle - Tuxpeño
5J	Mateo, Francisco Morazán	6865	175K	9.6	29.2	Salvadoreño - Tepecintle - Tuxpeño
6J	Mateo, Francisco Morazán	3300	159K	14.0	39.6	Salvadoreño - Tepecintle - Tuxpeño
7J	Aldea Monte Redondo, Fco. Morazán	4555	179K	12.6	36.8	Salvadoreño - Tepecintle - Tuxpeño
10J	Aldea Monte Redondo, Fco. Morazán	5010	180K	13.8	41.2	Salvadoreño - Tepecintle - Tuxpeño
12J	La Brea, La Patuique	5010	181K	12.2	33.6	Salvadoreño - Tepecintle - Tuxpeño
14J	Jutiapa, Fco. Morazán	5940	184K	12.4	31.8	Salvadoreño - Tepecintle - Tuxpeño
15J	San Juancito, Fco. Morazán	3830	177K	13.8	43.2	Salvadoreño - Tepecintle - Tuxpeño
20J	Valle de Angeles, Fco. Morazán	4225	182K	10.0	28.0	Salvadoreño - Tepecintle - Tuxpeño
21J	Choluteca	130	169K	12.0	36.4	Salvadoreño - Tepecintle - Tuxpeño
32J	Aldea Monterrey, Dto. Cortés	30	170K	12.0	39.0	Salvadoreño - Tepecintle - Tuxpeño
41J	Aguatenque, Comayagua	9900	185K	11.2	29.4	Salvadoreño - Tepecintle - Tuxpeño
50J	Aguatenque, Comayagua	2245	174K	13.6	41.4	Salvadoreño - Tepecintle - Tuxpeño
55J	Talanga, Fco. Morazán	2640	160K	13.8	44.6	Salvadoreño - Tepecintle - Tuxpeño
62J	El Porvenir, Fco. Morazán	2245	165K	13.0	35.4	Salvadoreño - Tepecintle - Tuxpeño
66J	San Ignacio, Fco. Morazán	2440	172K	14.0	38.4	Salvadoreño - Tepecintle - Tuxpeño
76J	El Portillo, Concordia	2380	173K	14.4	42.6	Salvadoreño
78J	Concordia, Olancho	2310	162K	14.4	40.6	Tepecintle
82J	Sta. María El Real, Olancho	1320	163K	13.0	37.0	Flint Dent
83J	Sta. María El Real, Olancho	1320	178K	13.6	42.0	Tepecintle
102J	El Aguacate, Dto. Cortés	130	164K	13.0	40.0	Flint Dent
Nicaragua						
2	Chinandega, Nicaragua	165	35N	12.6	41.0	Salvadoreño
33	Umure Matajalpa	1980	36N	12.6	40.6	Salvadoreño
3357	Monimbo, Masaya	1200	155K	11.2	29.8	Salvadoreño
3378	La Estrella, El Viejo, Chinandega	250	156K	11.4	31.6	Salvadoreño
3380	La Mora, Chinandega	500	154K	12.6	37.2	Salvadoreño
3401	Las Delicias El Tuma, Matagalpa	1000	153K	13.6	40.8	Salvadoreño
3406	Santa María de Ostuma, Matagalpa	3700	151K	11.2	32.6	Salvadoreño
3411	Boniche, Yali, Jinotega	3600	148K	10.4	28.8	Salvadoreño
3424	Yalaguina, Sonoto	1900	145K	13.0	40.8	Salvadoreño
3429	Calabaza, Esteli	2500	150K	13.4	39.0	Salvadoreño
3432	San Isidro, Matagalpa	1400	147K	12.6	35.4	Salvadoreño
3445	Agua Fría-Santo Tomás, Chontales	1200	149K	14.0	42.0	Salvadoreño
3449	Ocotal, Nueva Segovia	1500	152K	12.2	35.8	Salvadoreño

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Costa Rica						
5	San Luis de Acosta	3300	125K	11.8	32.0	Flint
11	Cartago	4600	133K	9.2	20.2	Montaña
12	El Pedregal, San Isidro de Guarco, Cartago	4950	137K	8.4	19.0	Montaña
18	Conchera, San Isidro	4290	132K	8.0	16.8	Montaña
22	Los Angeles Pérez Zeledón San Ignacio de Acosta	2370	127K	11.2	30.6	Flint
26	Rivas de Pérez Zeledón San Ignacio de Acosta	3300	126K	10.6	29.2	Flint
37	Santa Rosa, Pérez Zeledón	2830	129K	10.8	29.6	Flint
42	Sn. Juan Pérez Zeledón, Sn. José	3960	130K	10.6	26.4	Tuxpeño
45	Penhurst (Línea Estutla) Pto. Limón	60	104K	10.8	32.0	Amarillo Puerto Limón
58	Venecia, San Carlos, Alajuela	1155	105K	13.6	40.8	Amarillo Alajuela
59	Venecia, San Carlos, Alajuela	1155	113K	11.2	29.2	Maicena Flexible
59A	Sn. Juan de Urén, Pto. Viejo, Limón	260	142K	11.2	33.0	Maicena Flexible
63	Sta. Clara, Sn. Carlos, Alajuela	490	108K	12.2	32.0	Amarillo Alajuela
71	Florencia Sn. Carlos, Alajuela	820	106K	11.6	32.0	Coastal Tropical Flint - Cuban Flint
86	Sn. Luis Alfaro Ruiz, Alajuela	4790	139K	11.4	30.8	Flint
92	Florencia Sn. Carlos, Alajuela	760	114K	13.4	37.0	Maicena Flexible
95	Quebrada Azul Sn. Carlos, Alajuela	430	107K	10.6	28.6	Amarillo Alajuela
97	Pital, San Carlos, Alajuela	530	120K	12.8	36.4	Tuxpeño
103	Delicias, Upala, Alajuela	165	124K	12.2	33.4	Grano Ancho - Harinoso Rojo
107	Monte Cristo de Upala, Alajuela	100	109K	14.4	42.8	Azufrado
114	Sta. Cruz, Cacao, Guanacaste	660	112K	12.4	34.6	Maicena Flexible
135	La Duata, Cacao Sta. Cruz, Guanacaste	265	123K	12.8	35.6	Harinoso Negro
138	Veintisiete de Abril, Guanacaste	200	110K	12.8	37.6	Salvadoreño
166	Los Angeles, Tilarán, Guanacaste	1320	115K	14.0	44.0	Maicena A (Pira)
182	Juntas Abrigaur Polina	410	111K	13.6	37.6	Tuza Morado Salvadoreño
254	Cramanciagüe, Buenos Aires, Puntarenas	1320	118K	10.0	21.8	Unclassified
279	Mellisas Salitre, Puntarenas	4125	119K	9.8	24.4	Montaña
280	Río Nuevo, Pto. Jiménez, Puntarenas	165	121K	11.2	27.8	Coastal Tropical Flint
296	Santiago Puriscal	3230	122K	13.0	36.6	Flint
315	Sn. José de Naranjo, Alajuela	4290	140K	9.4	25.6	Montaña
334	Paso Ancho, Cartago	5775	134K	6.0	13.6	Montaña
345	Copey Dota, San José	6270	138K	8.3	23.3	Capia
379	Puerto Humo, Nicoya, Guanacaste	66	117K	14.0	37.2	Maicena A (Pira)
380	Puerto Humo, Nicoya, Guanacaste	66	116K	13.6	41.0	Maicena Flexible
400	Sabana Redonda de Poas	4420	141K	9.2	22.4	Montaña Medio
Panama						
2B	El Palomar, El Pantano, Santa Fe (Veraguas)	1650	80K	14.2	53.6	Coastal Tropical Flint - Pira
18B	Cerro Redondo, Bisvalles, La Mesa Veraguas	590	81K	12.6	39.2	Coastal Tropical Flint - Pira
31B	El Jagüito, El Poble, Aguadulce, Coclé	100	82K	11.0	40.2	Calello - Coastal Trópical Flint - Tuzón
36B	San José, Aguadulce Coclé	100	83K	10.2	30.4	Amarillo - Coastal Tropical Flint - Tuzón
2C	Aserría, La Unión, Chiriquí	900	86K	11.3	40.2	Amarillo - Coastal Tropical Flint - Tuzón

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Panama							
	11M	Río Diablo, Chepo, Panama	330	100K	11.8	36.4	Chepo Carioca
	12M	Río Diablo, Chepo, Panama	330	102K	12.2	38.0	Chepo Morado
	13M	Río Diablo, Chepo, Panama	330	99K	9.8	24.0	Chepo Amarillo
	20M	Ipetí, Chepo, Panama	360	101K	11.8	38.0	Chepo Carioca
	5P	San Miguel, Concepción, Chiriquí	1190	88K	13.0	49.0	Morado
	7P	Cuesta de Piedra, Concepción, Chiriquí	3135	103K	9.0	21.6	Am. Tico de Cartago
	11P	El Bongo, Bugaba, Concepción, Chiriquí	2210	89K	9.6	25.2	Am. Tico de Cartago
	12P	Buenavista, Bugaba, Concepción, Chiriquí	2540	90K	10.2	28.6	Am. Tico de Cartago
	15P	Boquete, Boquete, Chiriquí	4880	94K	8.2	18.4	Am. Tico de Cartago - Montaña
	20P	Horqueta, Boquete, Chiriquí	4620	95K	8.8	17.0	Montaña Blanco
	21P	Horqueta, Boquete, Chiriquí	4620	96K	7.6	19.2	Montaña Morado
	23P	Paraíso, Parita (Colonia) Herrera	100	85K	10.8	37.8	Coastal Tropical Flint - Tuzón
	28P	El Coco, Pesé, Herrera	390	84K	10.2	37.8	Coastal Tropical Flint - Tuzón
	35P	Visita, Chepo, Panama	180	91K	10.4	31.6	Coastal Tropical Flint - Tuzón
	39P	Isla Taboga, Taboga, Panama	100	92K	11.6	32.0	Coastal Tropical Flint - Tuzón
	3Q	Agua Buena, Tolé, Chiriquí	3300	93K	11.3	32.3	Coastal Tropical Flint - Tuzón
	18Q	Potrero de Palma, San Juan, Chiriquí	3960	98K	9.6	26.4	Caracol Negro
Ecuador							
	396	El Altar, Chimborazo	High	14	1.2	2.1	Canguil
	413	Cusubamba, Cayambe, Pichincha	8580	15	4.8	10.2	Canguil
	443	Calacali, Quito, Pichincha	9300	16	4.8	11.6	Canguil
	447	Tabacundo, Pedro Moncayo, Pichincha	9300	17	5.2	12.6	Canguil
	943	Guano Matriz, Chimborazo	7920	18	8.0	21.2	Canguil
Bolivia							
	344	Pautipampa, Cercado, Tarija	6270	7	5.0	11.2	Pisinkalla
	570	Ocobaya, Chulumani Sud-Yungas, La Paz	5940	10	5.5	14.5	Pisinkalla-Pororo
	693	Villa Pérez Charazani, Bautista Saavedra, La Paz	-	11	1.8	3.4	Pisinkalla-Pororo
	760	Inquisivi, Inquisivi, La Paz	8380	8	3.0	5.4	Pisinkalla
	780	Canton Ivo, Cordillera, Santa Cruz	3630	12	4.2	9.6	Pisinkalla-Pororo
	806	Robore, Prov. Chiquitos, Santa Cruz	-	13	7.0	14.8	Pororo
	864	Capinota, Capinota, Cochabamba	7900	9	3.0	6.2	Pisinkalla
	1143	Pando, Bolivia	-	19	2.4	3.8	Enano
	1144	Pando, Bolivia	-	20	2.0	2.0	Enano
Anchashino							
	250	Perú		2	3.0	5.0	Confite Puntiagudo
Peru							
	378	Tambillo, Huamanga, Ayacucho	8250	1	0.8	1.4	Confite Morocho (Aya. 4)
	685	Tarabamba, Urubamba, Cuzco	-	4	3.7	6.5	Confite Morocho
	963	Huallanca Yungay, Huaylas, Ancash	4620	6	5.0	9.6	Confite Morocho
Colombia							
Cun.	401	Gacheta, Cundinamarca, Colombia	5940	9N	7.4	28.6	Pollo Amarillo
M57A	7708#	Composite	-	1N	6.8	26.0	Pollo Segregaciones
M57A	7701#	Composite	-	8N	13.2	53.4	Pira Blanco

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		Place	Altitude (ft.)		Mean No.	Mean vol.	
Venezuela							
	678	La Torta, Aragua, Anzoategui	265	2N	11.7	45.7	Aragüito
	558	Mucuruba Escaguey, Rangel, Merida	-	3N	11.2	45.2	Sabanero
	513	Venezuela		4N	12.2	43.4	Canilla Venezolano
	459	Venezuela		5N	13.2	50.2	Guaribero
	461	Venezuela		6N	12.2	41.6	Costeño - Canilla
	530	Venezuela		7N	13.0	43.0	Guaribero
Argentina							
	481	Argentina		42	3.6	7.2	Pisincho
Pakistan	-	Kelta, Pakistan	-	21	4.6	10.8	Popcorn